INDUSTRIAL MEDICINE *and* SURGERY

Established 1932

AUGUST 1960

Volume 29 Number 8

Full-Time Corrective Action

in mild depression and chronic fatigue

Deaner®

tablets deanol acetamidobenzoate

Improves *night-time* restoration and *day-time* performance

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  ...permits sounder sleep
  ...lessens sleep requirements
- Increases daytime energy
- Counteracts mild depression
  ...acts to stabilize emotionally disturbed patients with or without concomitant disease
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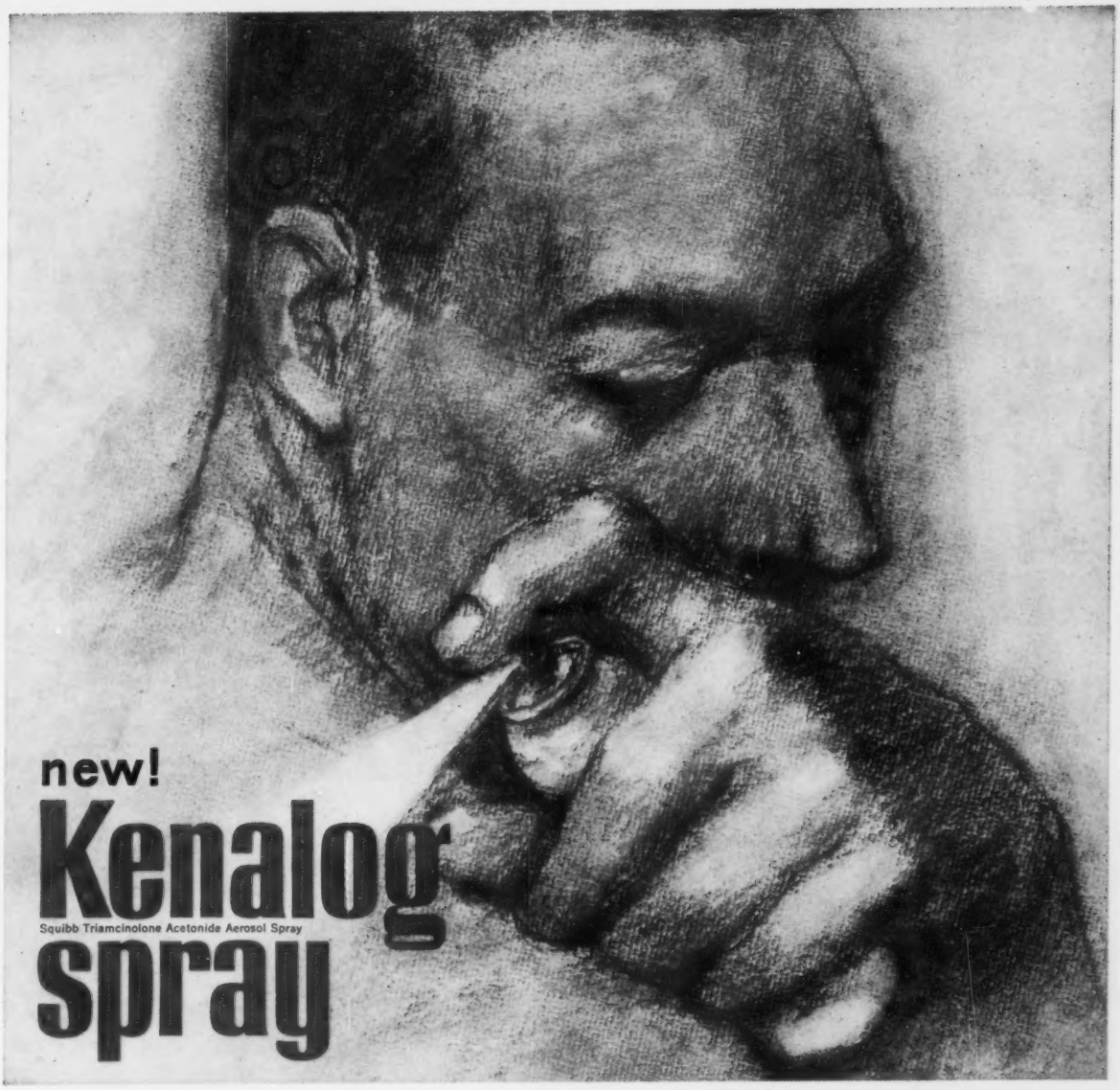
'Deaner' is supplied in scored tablets containing 25 mg. of 2-dimethylaminoethanol as the *p*-acetamidobenzoic acid salt.

In Mild Depression

chronic fatigue and many other emotional and behavioral problems

Literature, file card and bibliography on request

Riker Northridge, California



superior topical corticosteroid

In convenient aerosol spray—for the treatment of dermatoses, particularly in out-of-reach problem areas—a fresh approach to therapy

- the superior anti-inflammatory effect of Kenalog[1-7] provides anti-inflammatory, antiallergic, and antipruritic relief in acute, exudative, weeping lesions, even in extensive, out-of-reach problem areas.
- minimal local irritation and less chance of local contamination.
- metabolic studies show electrolyte disturbance does not occur when Kenalog is applied topically.[1, 4, 5]
- easy to apply, gives broad, even coverage, and permits observation of lesions as they heal.

Indications: Atopic dermatitis, contact dermatitis, eczematous dermatitis, neurodermatitis, seborrheic dermatitis, insect bites, pruritus ani and vulvae, lichen simplex chronicus, exfoliative dermatitis, stasis dermatitis, nummular eczema, sunburn.

Dosage: Apply the spray to the affected areas from a distance of 3 to 6 inches, t.i.d. or q.i.d. A 3-second spray (delivering approximately 0.1 mg. of triamcinolone acetonide) covers an area about the size of the hand. *Cover the eyes when using Kenalog Spray on or near the face.*

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References: 1. Reports to the Squibb Institute for Medical Research. 2. Howell, C. M.: Squibb Clin. Res. Notes *1*:5 (Oct.) 1958. 3. Goodman, J. J.: Squibb Clin. Res. Notes *1*:1 (Oct.) 1958. 4. Smith, J. G., Jr.; Zawisza, R. J., and Blank, H.: Squibb Clin. Res. Notes *1*:6 (Oct.) 1958. 5. Fitzpatrick, T. B.; Crowe, F. W., and Walker, S. A.: Squibb Clin. Res. Notes *1*:1 (Oct.) 1958. 6. Lerner, A. B.: Squibb Clin. Res. Notes *1*:2 (Oct.) 1958. 7. Robinson, R. C. V.: Bull. School of Med., U. Maryland *43*:54 (July) 1958.

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CHYMORAL PRODUCED GOOD TO EXCELLENT RESULTS IN 8 OUT OF EVERY 10 CASES WITH NO REPORTED TOXICITY OR SIDE EFFECTS[1-4]

condition	no. of cases	excellent/good	fair	no response
contusions, lacerations, miscellaneous trauma	164	137	19	8
fractures, sprains & strains	64	44	14	6
TOTAL	228	181	33	14

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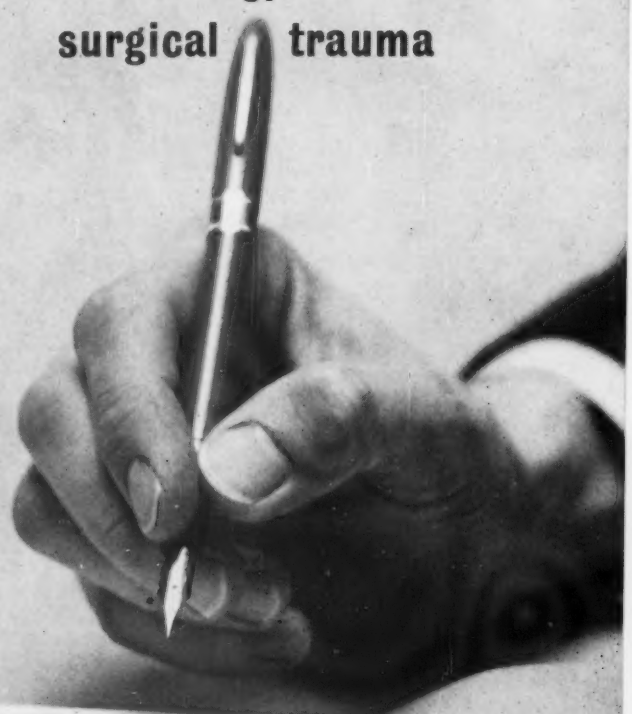
1. Billow, B. W., *et al.*: Southwestern Med. *41*:286, (May) 1960.
2. Teitel, L. H., *et al.*: Indust. Med. *29*:150 (April) 1960.
3. Beck, C., *et al.*: Clin. Med. *7*:519 (March) 1960.
4. Clinical Reports to the Medical Dept., Armour Pharmaceutical Co., 1959.

in accidental or surgical trauma



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INDUSTRIAL MEDICINE and SURGERY

ESTABLISHED 1932

The International Journal of Medicine in Industry

AUGUST, 1960
VOLUME XXIX
NUMBER 8

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PERSONAL NEWS AND NOTES

SEWARD E. MILLER, M.D., the Chairman of the United States Delegation to the Permanent Committee and International Association on Occupational Health, announces the election of the following persons to membership in the Delegation: ANNA M. BAETJER, Sc.D.; E. S. JONES, M.D.; A. G. KAMMER, M.D.; ROBERT A. KEHOE, M.D.; O. A. SANDER, M.D.; JAMES H. STERNER, M.D. Other members of the U. S. Delegation are: HEINRICH BRIEGER, M.D.; LEONARD GREENBURG, M.D.; PROF. THEODORE F. HATCH; EDWARD C. HOLMBLAD, M.D.; H. S. KUHN, M.D.; CAREY P. McCORD, M.D.; SEWARD E. MILLER, M.D.; NORBERT J. ROBERTS, M.D.; OTIS B. SCHREUDER, M.D.; SARA P. WAGNER, R.N.

At the time of the 13th International Congress in New York in July, 1960, DR. ANTHONY J. LANZA and DR. ROYD R. SAYERS of the United States together with DR. FRANZ KOELSCH of Germany were elected to Honorary Membership in that body.

The Columbia University School of Public Health and Administrative Medicine Program of Continuation Education announces its Fourth Annual Institute for Physicians in Industry to be held February 3-7, 1961, in New York City.

Intensive instruction will be offered in some or all of the following subjects: epidemiology, biostatistics, toxicology, radiation, air pollution, occupational medicine (general review) and applications of insurance in occupational medicine.

The Institute is cosponsored by the American Academy of Occupational Medicine.

For further information inquiries may be directed to: Program of Continuation Education, School of Public Health and Administrative Medicine, 600 West 168th Street, New York 32, New York.

ANTHONY J. LANZA, M.D., Professor Emeritus, Department of Industrial Medicine, Post-Graduate Medical School of the New York University Medical Center, is the recipient of the New York University Presidential Citation. The presentation of the Citation was made at a reception in DR. LANZA'S honor which was held on July 27, 1960, at the New York University Medical Center.

DR. TOMAS ARAMBURU DIEZ was elected President of the Cuban Society for Industrial Medicine. He will serve until 1962. Other new officers of the society are: Vice-Presidents, DR. MARCELO DE CATURLA JIMENEZ, DR. RAFAEL PENALVER BALLINA; Secretary General, DR. ANTONIO J. FERNANDEZ MENENDEZ; Treasurer, DR. MANUEL TABOAS GONZALEZ. Other directors of the society are: DR. OSWALDO MORALES PATINO, DR. FRANCISCO LANCIS SANCHEZ, DR. BENITO DURAN CASTILLO, and DR. ALBERTO SUAREZ URGELLES.

The Industrial Hygiene Foundation will hold its 25th annual meeting at the Mellon Institute in Pittsburgh on October 26 and 27, 1960. Information about the meeting may be obtained from DR. H. H. SCHRENK, Managing Director, Industrial Hygiene Foundation, 4400 Fifth Avenue, Pittsburgh 13, Pa.

DOUGLAS H. K. LEE, M.D., has been appointed chief of the research headquarters of the Occupational Health Program, Public Health Service, U. S. Department of Health, Education, and Welfare, at Cincinnati, Ohio. In his new position, he will be responsible for directing technical research and field studies of occupational health problems and professional and technical consultation services to state agencies, labor, and industry.

Prior to his association with the Public Health Service, DR. LEE had been in charge of the research program of the Quartermaster Corps, Department of Army. Previously, he was Dean of the Faculty of Medicine and Head of Department of Physiology at the University of Queensland in Brisbane, Australia, and, later, on the faculty at Johns Hopkins University. His major research interests have dealt with

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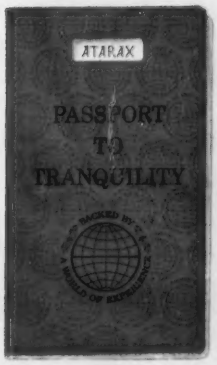

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IN AMBULATORY NEUROTICS	"Since this drug does not impair psychic function... it is especially well suited for ambulatory neurotics who must work, drive a car, or operate machinery." Ayd, F. J., Jr.: New York J. Med. **57**:1742 (May 15) 1957.	Garber, R. C., Jr.: J. Florida M. A. **45**:549 (Nov.) 1958. Menger, H. C.: New York J. Med. **58**:1684 (May 15) 1958.
IN PREMENSTRUAL TENSION	"The consensus appears to be that this agent has a definite calming effect on nervous and agitated subjects with symptoms such as... premenstrual tension...." Shalowitz, M.: Geriatrics **11**:312 (July) 1956.	Schuller, E.: Gaz. des Hôpitaux **129**:391 (Apr. 10) 1957. Dolan, C. M.: California Med. **88**:443 (June) 1958.
IN ALCOHOLISM	Atarax "... is the tranquilizer of choice in the treatment of both acute and chronic stages, inpatient and outpatient, because of its safety, versatility, flexibility, and effectiveness." McGettigan, D. L.: In press.	Cohen, S.: Am. Pract. & Digest Treat. **8**:946 (June) 1957. Garber, R. C., Jr.: J. Florida M. A. **45**:549 (Nov.) 1958.

Dosage: One 25 mg. tablet or one tbsp. syrup q.i.d. For emotional emergencies, 25-50 mg. (1-12 cc.) I.M., 3-4 times daily q. 4 h. **Supplied:** Tiny 10 mg., 25 mg., and 100 mg. tablets. Syrup (10 mg. per tsp.), pint bottles. Parenteral Solution: 25 mg./cc. in 10 cc. multiple-dose vials; 50 mg./cc. in 2 cc. ampules. Prescription only.

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Science for the World's Well-Being

the effect of climate on man and animals and related studies on clothing, housing, and production.

He also served as consultant to the Food and Agriculture Organization of the United Nations, the Bureau of Dairy Industry of the U. S. Department of Agriculture, and the U. S. Department of Defense. In addition to the United States and Australia, his investigations have covered New Guinea, Malaya, Venezuela, and India.

Born in Bristol, England, DR. LEE received his education in England and Australia. A graduate of the University of London and the University of Sydney, he holds degrees in medicine and tropical medicine. He is a Fellow of the Royal Australasian College of Physicians and a member of the Society of the Sigma Xi, the Physiological Society of Great Britain, and the American Physiological Society. He is the author of numerous publications.

A "Short Course in Audiology" will be offered several times each year by the Section of Audiology, Department of Otorhinology, Temple University School of Medicine, Philadelphia 40, Pa. The course will be one week in length and will encompass theoretical and clinical aspects of audition. Hearing testing and interpretation will be stressed. Office procedures, equipment and industrial audiometry will be discussed.

Further information may be obtained by writing to PHILIP E. ROSENBERG, Ph. D., Director, Section of Audiology, Temple University Medical Center, 3401 North Broad St., Philadelphia, Pa.

The Third World Congress on the Prevention of Occupational Exposures will assemble in Paris, France at the Palais de Chaillot, on May 22-27, 1961. This Congress will be staged under the sponsorship of the National Safety Institute of France. The elaborate program will embrace both accidental injuries and occupational diseases.

The readers of the journal, and in particular the organizations that they represent, are invited to attend this World Congress and to participate in its deliberation.

Detailed information may be procured from the Institut National De Securite, Secretaria del tercer Congreso mundial, Avenue Montaigne, Paris, 8°-9, France.

The National Safety Council has named DEBRA GLOVER, R.N., to head its medical department and to be the Council's occupational health nursing representative.

MRS. GLOVER will supervise the Council's health and nursing services to its industrial member firms, and will supervise also the Council's employee health program in its Chicago headquarters.

A full-time one-week course in industrial health for nurses will be given beginning October 31, 1960, by the Department of Industrial Medicine of New York University Post-Graduate Medical School, of the New York University Medical Center.

The course, limited to 50 nurses engaged in industrial nursing, will be given under the direction of DR. DAVID H. GOLDSTEIN, Professor of Industrial Medicine at the Post-Graduate Medical School.

Instruction consists of lectures and conferences led by both medical and nursing faculty of the Medical Center. A field trip of half a day will permit a visit to and a study of an industrial medical department in the Greater New York area.

Several sessions will be held jointly with industrial physicians enrolled in postgraduate study.

Applications should be sent to the Dean, NYU Post-Graduate Medical School, 550 First Avenue, New York 16, New York. Tuition: $60. Course 484.

A conference on "New Environmental Problems in the Construction Industry" will be held at Austin, Texas, on December 3, 1960. The conference will be jointly sponsored by the College of Engineering, University of Texas; Environmental Sanitation Service, Texas State Department of Health, and the Gulf Coast and North Texas sections of the American Industrial Hygiene Association. Information is available from E. F. GLOYNA, Professor of Civil Engineering, The University of Texas, Austin, Texas.

GRANVILLE W. LARRIMORE, M.D., New York State Deputy Commissioner of Health and Chairman of the 1961 Forum Committee, announces that the 1961 National Health Forum on "Better Communication for Better Health" will be held March 13-16, at the Waldorf Astoria Hotel in New York City. This will be the ninth annual National Health Forum sponsored by the National Health Council on behalf of its 71 member agencies.

Three pre-Forum Workshops, to be held in various parts of the country, will consider communication among the health professions and communication between health organizations and the general public. It is anticipated that these Workshops will provide a basis for the discussions at the Forum itself, when 600 invited leaders in the fields of health will examine together ways to improve communication for better health.

SALLY KREGER, R.N., of Paramount Pictures Corporation, has received the 1960 Award of Merit in Industrial Nursing given by the Public Health Association of New York City. MRS. KREGER has been chairman of the Greater New York Association of Industrial Nurses, Inc., education committee and has worked to introduce courses in industrial nursing into the curriculum of nursing schools in the New York area.

The appointment of WILLIAM H. HUNT of North Plainfield, N. J., as toxicologist for Monsanto Chemical Company here was announced by DR. R. EMMET KELLY, Director of Monsanto's Medical Department. HUNT has been research pharmacologist for Ethicon, Inc., of Somerville, N. J., for the past two years. From 1953 to 1958 he was in the toxicology division of the E. R. Squibb & Sons Institute of Medical Research, New Brunswick, N. J.

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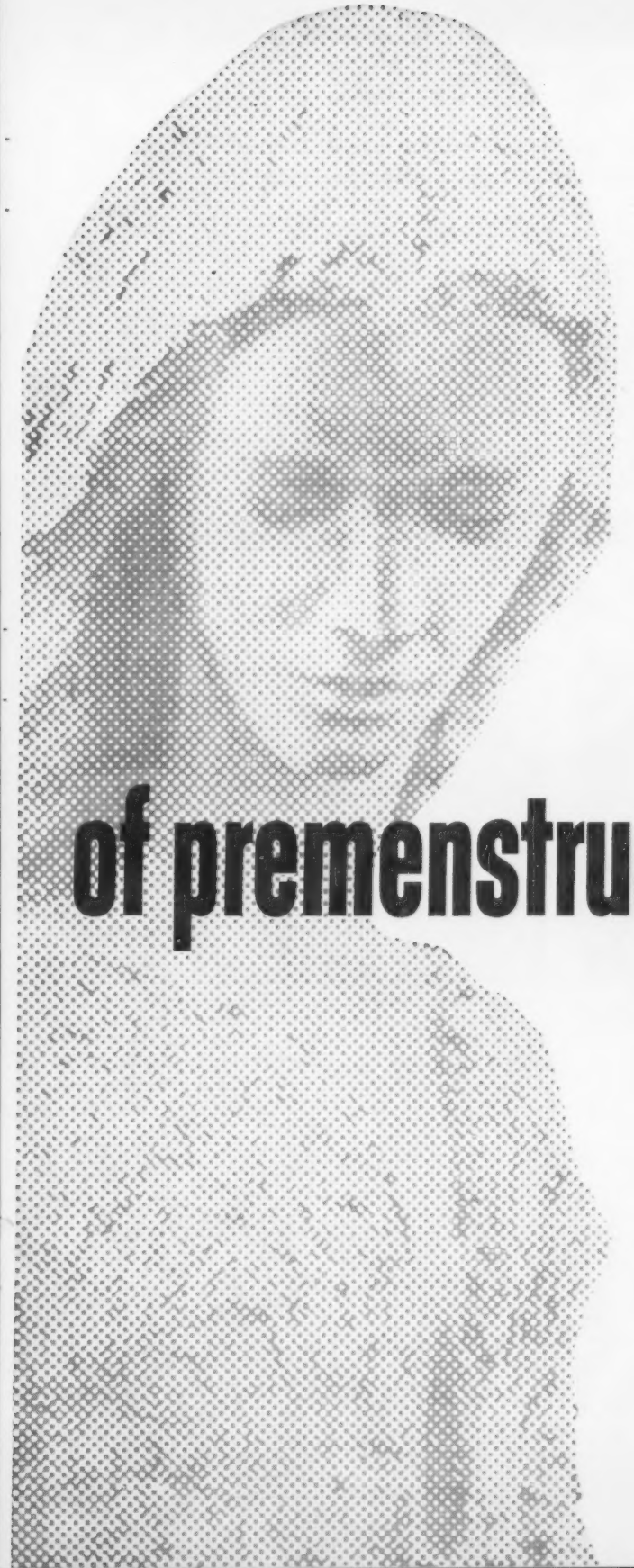
CYCLEX affords quick-acting relief of nausea and bloating associated with premenstrual tension.



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One CYCLEX Tablet 1 or 2 times daily, beginning when symptoms appear and continuing until the onset of menses.

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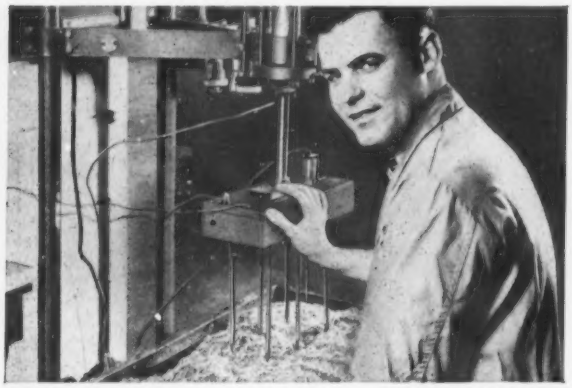

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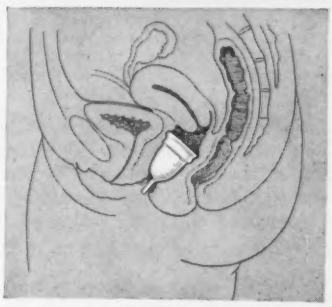
Tassette permits your patient to swim, dance and engage in any activity because it catches the flow and seals it off completely. Thus there is no odor or possibility of leakage or staining as may occur during periods of heavy flow when tampons are used. There is no danger of chafing, irritation or infection, and no belt is required, as with ordinary sanitary napkins.

Tassette has many medical applications other than its use as a menstrual cup. During the intermenstrual period it provides the most satisfactory and safe method for collecting vaginal, cervical or uterine secretions for diagnostic purposes. Tassette has also been used to insure against leakages in vesico-vaginal fistula.

Modern internal menstrual control is now accepted by the medical profession and Tassette is widely recommended by gynecologists in place of sanitary napkins and tampons. In order to acquaint you with Tassette this special offer is made: Send $3.50 (reg. price $4.95) for one Tassette with complete directions, postage prepaid. Tassette guarantees satisfactory use for two years or your money back.



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At the first allergic sneeze, two inhalations from the **NTZ** Nasal Spray act speedily to bring exceptional relief of symptoms. The first spray shrinks the turbinates and enables the patient to breathe through his nose again. The second spray, a few minutes later, opens sinus ostia for essential ventilation and drainage. Excessive rhinorrhea is reduced. **NTZ** is well tolerated and provides safe "inner space" without causing chemical harm to the respiratory tissues.

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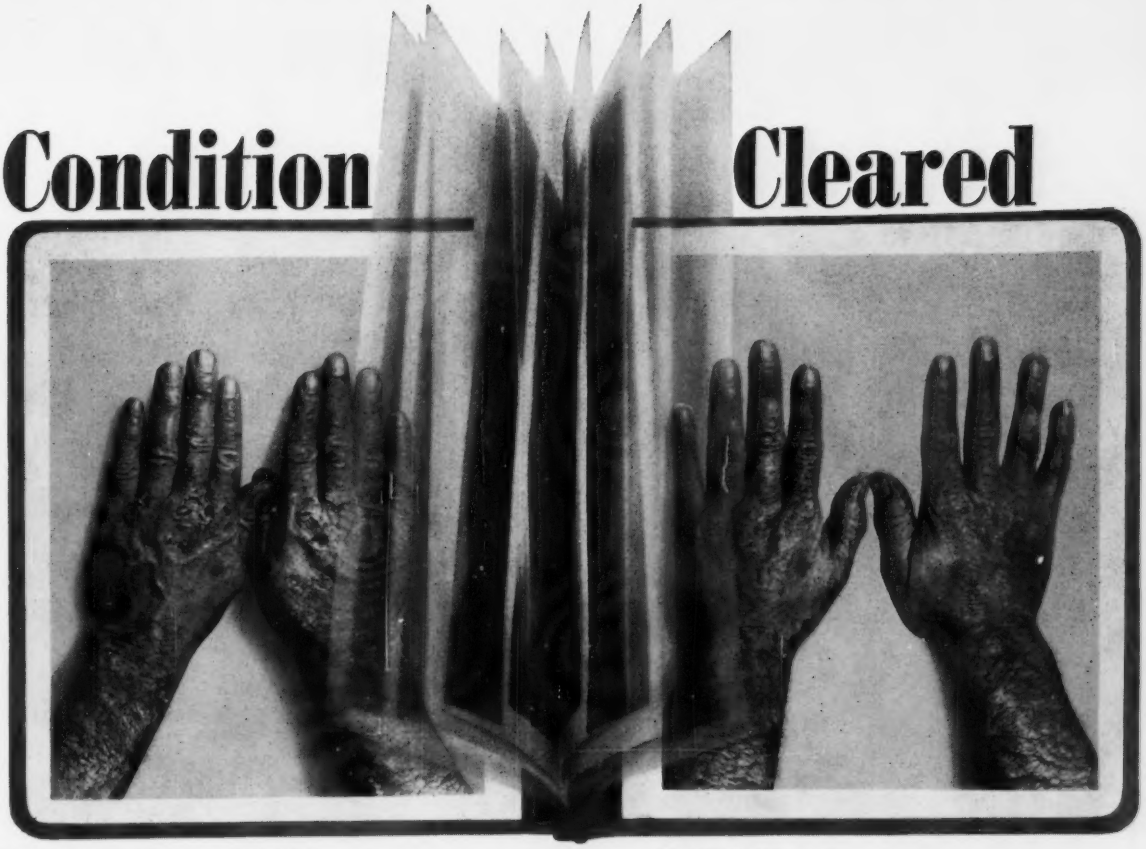

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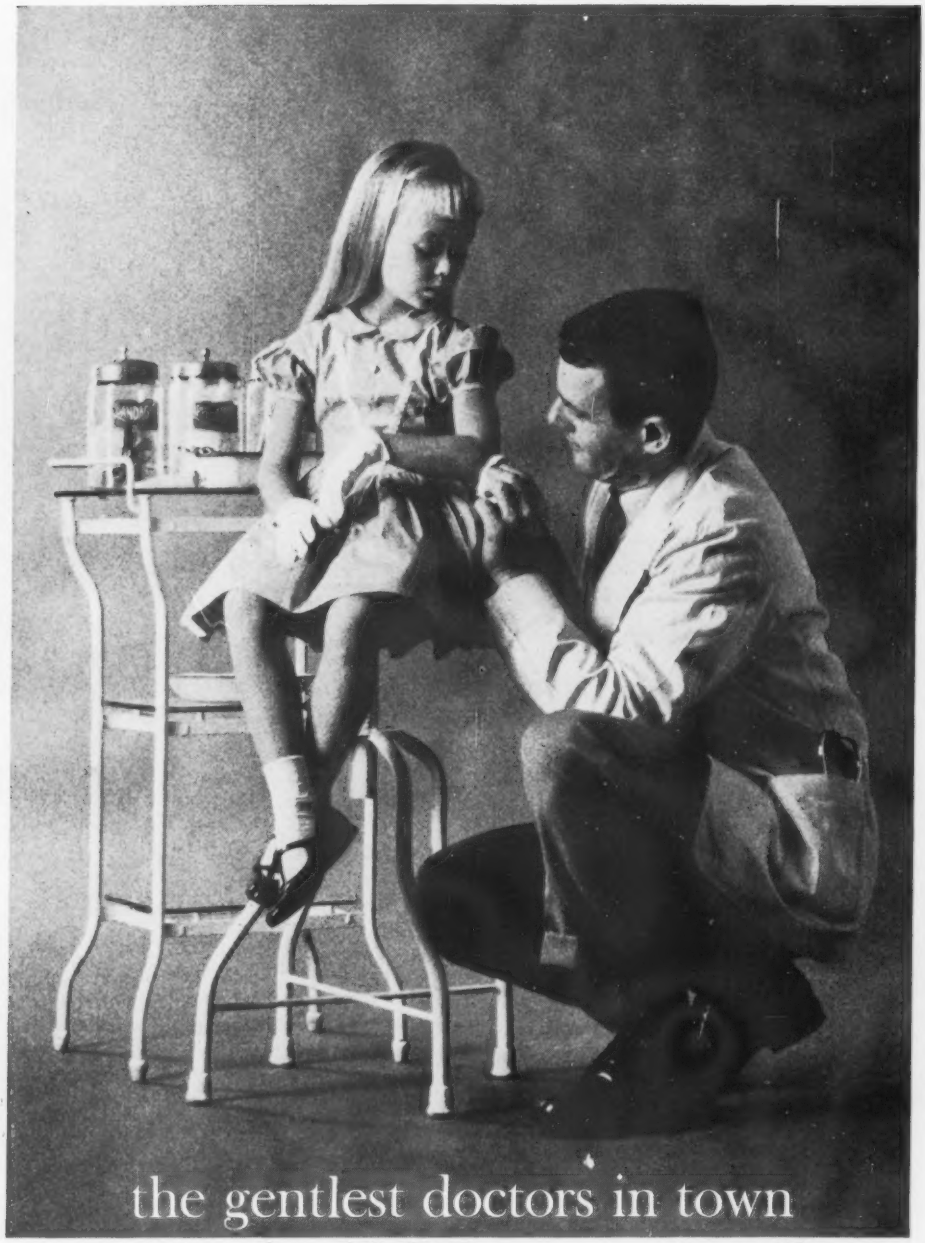

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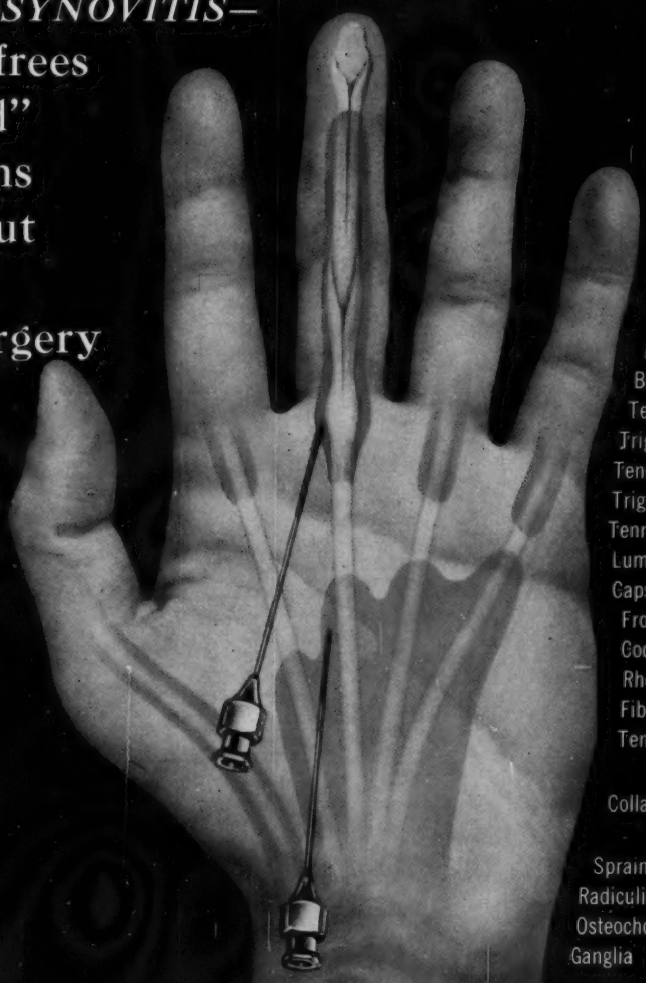

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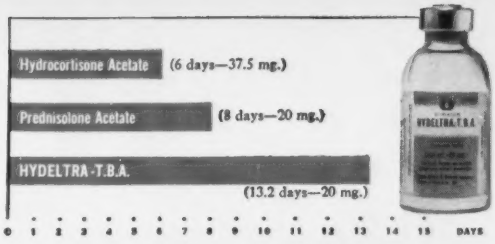
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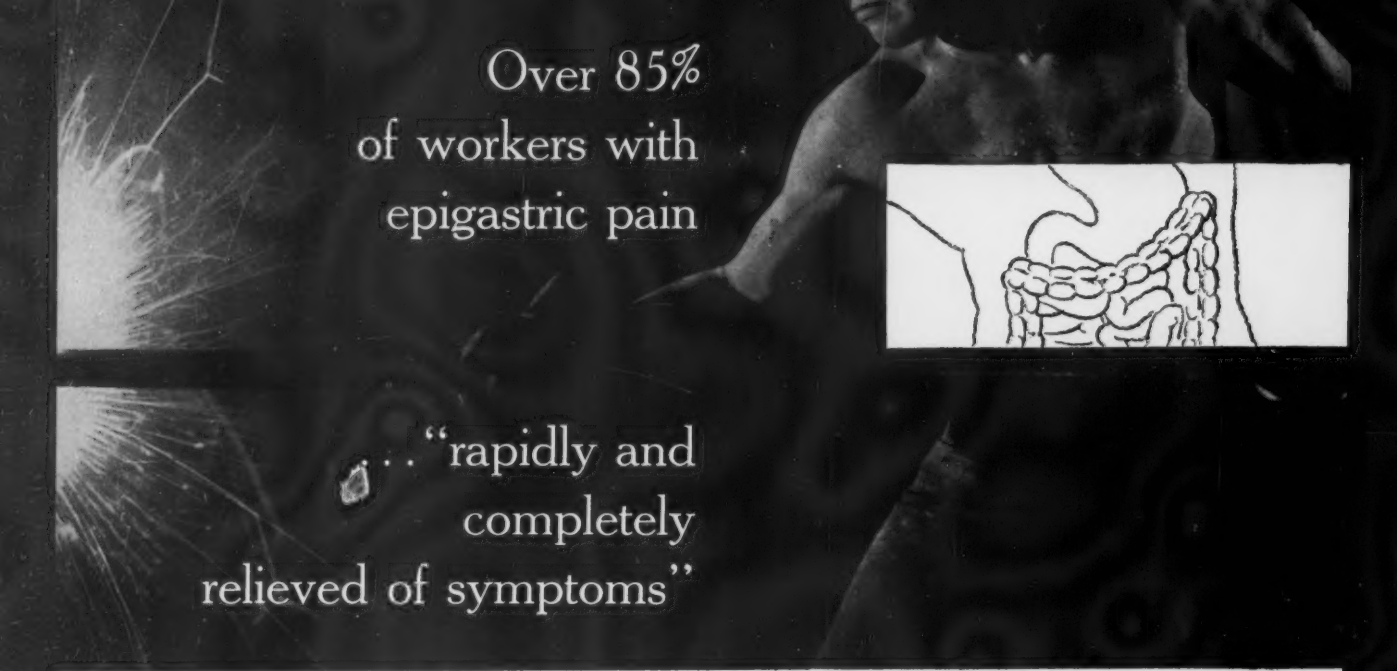

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are particularly useful for industrial therapy, because once-a-day dosage provides effective spasmolysis for a twelve-hour period without the inconvenience of the customary four-hour dosage schedule. True *extended action* spasmolytic effects are provided by the special construction of Extentabs. Immediately after administration the equivalent of one Donnatal tablet is released, followed by the gradual and uniform release of the equivalent of two more Donnatal tablets, to provide sustained effects for 10 to 12 hours.

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Donnatal Extentabs contain active ingredients equivalent to three regular Donnatal tablets—bottles of 100 and 500.

*Frank W. Barden, M.D., Paul S. Hill, M.D., William F. Mahoney, M.D., and Kenneth J. Cuneo, M.D., in a report from the Medical Department of the Saco-Lowell Shops and the Webber Memorial Hospital, Biddeford, Maine; published in the January, 1954 issue of the Journal of the Maine Medical Association (Vol. XXXXV, No. 1, Page 11).

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Blank, H.; Smith, J. G., Jr.; Roth, F. J., Jr., and Zajas, N.: J.A.M.A. **171**:2168 (Dec. 19) 1959.

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References: Annals of Allergy, Vol. 6. July-August 1948. Study of a New Histamine Antagonist, The Pennsylvania Med. J., Vol. 51. Clinical Study of a New Antihistaminic Drug—Phenindamine. Dristan Clinical Study.

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1. Fullgrabe, E. A.: Ann. New York Acad. Sc. 68:192, 1957. 2. Jenkins, B. H.: J.M.A. Georgia 45:431, 1956. 3. Davis, O. F., et al.: Postgrad. Med. 26:719, 1959.

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DIFFUSE FIBROGENIC PNEUMOCONIOSIS

* ARTHUR J. VORWALD, Ph.D., M.D., F.C.C.P.
Professor and Chairman
Department of Industrial Medicine and Hygiene
Wayne State University
Detroit, Michigan

The pulmonary deposition of inhaled inorganic pollutants, in the form of dust, may be attended by changes in the lung which are indicative of a pneumoconiosis. In general, the pneumoconioses are usually recognized as belonging to one or the other of two major categories, namely, the biologically inert and benign or the biologically active and injurious. In order to establish a framework for discussion and for immediate reference, it is pertinent to present briefly certain features regarding the first of those categories.

Inert Pneumoconioses

The inert pneumoconioses concern those dusts which do not provoke a significant inflammatory reaction either in the lung or in the draining tracheobronchial lymph nodes. Although a variety of dusts could be cited in that regard, a classical example involves inhaled iron oxide, as illustrated by the case of a 56 year old white male who had worked for approximately five months as a millwright and 18 years as a burner in a steel mill. Because of a severe accident, he was hospitalized and, at that time, his chest roentgenograms disclosed a generalized mottling throughout both lung fields. Some of the focal shadows were nodular, but their borders were ill-defined. In addition, the right lung field disclosed the pulmonary component of a calcified primary complex, situated at the level of the seventh posterior interspace. The hilar shadows were not enlarged.

Two months after the above roentgen study, the patient died. Autopsy disclosed massive pulmonary embolization and infarction which were unrelated to the pneumoconiotic process discovered in his lungs and tracheobronchial lymph nodes. That process consisted of widely scattered focal and diffuse deposits of particulate brown-black pigment within phagocytes which had accumulated in the alveolar spaces, the septal walls, the perivascular connective tissue, the intrapulmonary lymphoid aggregates and the lymph nodes (Figure 1). Except for the general phagocytic response and for an occasional mild proliferation of septal histiocytes, there was no specific inflammatory reaction associated with the pigment which elicited a positive stain for iron.

Chemical analysis of representative portions of the lung, reported as percentage of dry tissue, revealed: Ash 20.88; Total Silica 0.35; Free

Read at the McIntyre Research Foundation Conference on Silicosis and Other Industrial Pulmonary Diseases, Toronto, Canada, January, 1960.

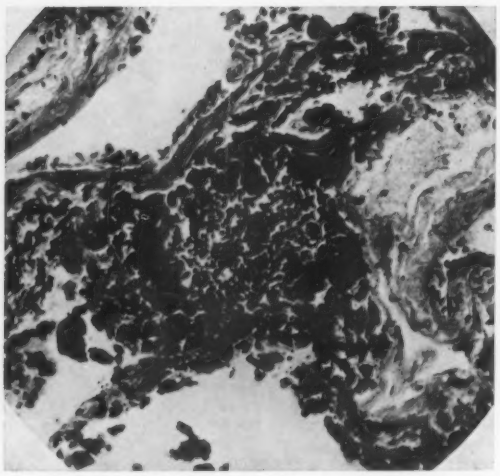


Figure 1
Black masses of iron pigment localized in lymphoid aggregate about a vascular trunk. Note absence of inflammatory reaction.

Silica 0.09; and Iron 8.28 or 82,800 ppm. With respect to the above it may be noted that the values for silica are low and well within the range for normal subjects of the general population. The value for iron, however, is extremely high. In fact, it is approximately 17 times higher than the mean concentration of 4,990 ppm of iron discovered in the lungs of 26 cases with no known occupational exposure. The relative biological inertness of inhaled iron oxide as seen in human subjects may also be observed in the lungs of experimental animals. Studies in this regard reveal that the prolonged exposure to the inhalation of a high atmospheric concentration of iron oxide (Fe_2O_3) with small amounts of free crystalline silica such as attend certain iron grinding and burning operations, is productive of focal pulmonary deposits which respectively cast shadows on the chest roentgenogram and which are without any significant pulmonary fibrosis. Pure iron oxide dust, experimentally deposited in the lungs via intratracheal injection, does not provoke a significant inflammatory reaction, even after 365 days.

Active Pneumoconioses

The second major category of the pneumoconioses involves those inhaled dusts which are active and thereby injurious. They provoke a specific inflammatory reaction which in terms of pulmonary pathology may be considered under two main headings, namely, one which is defined by nodular and/or seminodular lesions uniformly scattered throughout the entire lung, and the second which is characterized by a nonnodular, diffuse and widespread pneumonitis.

Nodular Pneumoconiosis: The nodular form of a pneumoconiosis is classically produced by the prolonged exposure to high atmospheric concentrations of extremely small particles of free crystalline silica, usually in the form of quartz dust. The gross and microscopic pattern of the discrete lesions may be modified somewhat by the presence of a nonsiliceous component of the inhaled dust. Consequently the periphery of the lesion is irregular with thick fingerlike extensions into the surrounding pulmonary parenchyma. Those extensions frequently merge thus forming stellate nodules. In general, however, the lesions of nodular silicosis, either simple or modified, tend to retain their basic discrete nodular pattern, unless complicated by infection. A modified form of simple nodular silicosis is exemplified by the case of a 50 year old white male who had worked for approximately 34 years as a mucker, drill runner, and roofman in the underground operations of an iron ore and hard rock mine. His periodic chest roentgenograms exhibited the gradual development and persistent presence of discrete nodular shadows widely distributed throughout both lung fields. Nine days before death, caused by a primary laryngeal carcinoma, his terminal chest x-ray film disclosed that the midlung fields were occupied by irregular diffuse densities, apparently due not only to the superimposition of the nodular shadows, but also to some coalesence of those nodules. Examination of his postmortem lung revealed a multitude of widely scattered, firm and pigmented nodules of hyalinized fibrous tissue. The nodules were predominantly discrete, even though some of them had merged to form larger irregular lesions (Figure 2). The pulmonary parenchyma

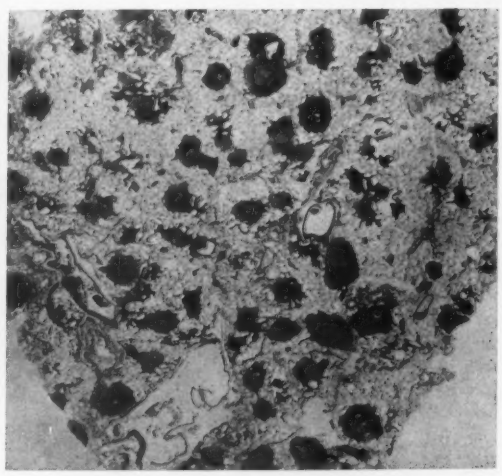


Figure 2
Scattered discrete nodules of modified, but simple silicosis.

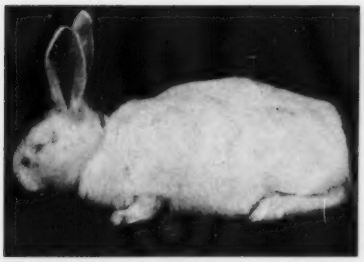


Figure 3
(Left) Normal Rabbit

Figure 4
(Right) Rabbit with respiratory distress provoked by the pulmonary deposition of silicon dioxide particles.

between the lesions was generally intact, except for an occasional mild perinodular emphysema. Simple nodular silicosis can be regularly produced in a variety of experimental animals, notably the albino rat and the rabbit, challenged by a prolonged inhalation exposure to free crystalline silica in the form of quartz dust. Studies in that regard disclose that there are significant direct relationships, not only with the intensity of the challenge in terms of duration of the exposure and concentration of the dust, but also with the nature of the silica, whether it is quartz or the more active forms such as cristobalite and tridymite. In addition to the above, the importance of particle size has long been recognized in pathogenesis of silicosis. There is an appreciable body of experimental evidence which indicates that inhaled free silica particles in the microscopic range of size, viz. from 0.1 to 5 microns in diameter, are productive of the nodular form of silicosis. As for example, rabbits with prolonged exposure to quartz dust of micronic size routinely develop simple nodular silicosis which bears many features that are similar to the disease in human subjects.

Diffuse Fibrogenic Pneumoconiosis: From an experimental viewpoint, and in contrast to the above, inhaled silica particles of ultramicroscopic size, viz. below the resolving power of the conventional optical microscope, induce a widespread chronic interstitial pneumonitis which is diffuse and nonnodular. Although the precise pathogenesis of that diffuse pneumonitis is still to be defined, it appears that the primary pulmonary deposition, retention, transport, and biologic activity of the ultramicroscopic particles are different than is the case with particles of silica, larger than 0.1 micron. Certain experimental studies in that regard may be cited. A group of normal rabbits were exposed, from 90 to 510 days, by inhalation to a silicon dioxide fume which had a mean atmospheric concentration of 1.47 mg. per cubic foot of air and which had a particle size range from 0.009 to 0.1 micron in diameter. A striking feature of the observations during the life of some of these rabbits pertained to their gradual development of respiratory difficulty which became more severe with increasing length of exposure (Figure 4). The difficulty was barely perceptible in some rabbits while resting. However, with excitement or exercise, their breathing became obviously labored, being shallow, rapid and through the mouth. The lips and ears revealed faint to deep cyanosis. The head was often hyperextended with the ears lying flat along the back, rather than in the erect position. The general body posture was one of intense anxiety with the front legs extended and the chest raised off of the underlying supportive framework. The fur was dull and in poor condition. These abnormal findings were in marked contrast to the relaxed posture of the healthy control rabbits living in clean air (Figure 3).

Physiologically, certain of the exposed rabbits were subjected to a number of procedures which included red blood count, hemoglobin and hematocrit evaluations, and intracardiac pressure determinations. Although there were no absolute correlations between the severity of the breathing difficulties and other findings, nevertheless at least two of the rabbits with marked respiratory distress disclosed a progressive and pronounced increase in their right intraventricular pressure.

Figure 5
Gross lung of rabbit, Figure 4. Note emphysematous bulla which bulge from the surface.

Pathologically, the lungs usually revealed some degree of emphysema which was directly proportional to the duration of exposure. In general, the emphysema was fine in type and diffusely distributed throughout all portions of the lung. In a few rabbits, with long exposure, the emphysema was coarse with the production of small

Figure 6
Chest roentgenogram showing diffuse shadows of chronic proliferative pneumonitis in a graphite worker.

and large bullae, often mainly localized in the anterior portions of the lobes (Figure 5). Microscopically, sections of the lung exhibited a chronic diffuse interstitial inflammation which thickened the alveolar walls with the production of scattered stellate lesions of cellular fibrosis.

The seemingly most important points to be made here are that a silicon dioxide fume of ultramicroscopic particles, when inhaled over a long period of time by rabbits, provokes in them a diffuse chronic pneumonitis which is attended by emphysema, increased right ventricular pressure, and respiratory distress. Although the changes are indeed experimental, they at least suggest that excessive quantities of inhaled silicon dioxide particles, in ultramicroscopic size, may induce similar events in human subjects. Notable in that regard are the furnace fumes which have attended the processing of bauxite for the manufacture of corundum and the aerosol of particulate cristobalite which has accompanied the high temperature calcination processing of diatomaceous earth. In addition to the above there are other well known diffuse fibrogenic pneumoconioses as indeed are other types such as classical asbestosis and talcosis. Rather than focusing further attention in their regard, it seems more appropriate to discuss here two cases of certain other diffuse pneumoconioses which have recently stimulated our clinical and experimental interests. In general, those cases involve the inhalation of a mixture of dusts. Accordingly, they exemplify, at least, some of the problems which are the subject of current debate.

The first case involves a white male whose occupational history disclosed a variety of jobs without any respiratory dust hazard. At 56 years of age, however, and for approximately 10 years thereafter he worked as a miller and screener of both natural and artificial graphite. After seven years at that work, he began to complain of progressive shortness of breath, accompanied by mild chest pains and cough with expectoration of black sputum. Approximately nine months after the appearance of those complaints his chest roentgenograms revealed widely scattered linear and focal densities, particularly prominent in the basilar portions of the right upper lobe. Four and one-half years later and approximately two years after having left that employment because of respiratory difficulty, his chest x-ray films disclosed diffuse densities in the right upper lobe and in both lower lobes. At that time there was definite roentgenographic evidence consistent with a slight increase in the size of the cardiac silhouette, chiefly, the right heart. Two years after the antecedent films, the patient suffered from profound respiratory distress with evidence of congestive heart failure. At that time his chest x-ray films showed a pronounced and generalized increase of the infiltrative densities in both lung fields (Figure 6). In addition the cardiac shadow, chiefly of the right heart, exhibited a marked increase with abnormal prominence of the vascular trunks at both hila. Five months later, the patient died.

At autopsy, the lungs disclosed a diffuse black pigmentation with extensive areas of dark grey to black indurative fibrosis which was attended by widespread emphysema. Microscopically, sections of the lung revealed focal and diffuse pigmented fibrosis which in some areas had coalesced to form massive fibrotic lesions with obliteration of the pulmonary architecture (Figure 7). So-called graphite bodies were discovered throughout the tissue, mainly in the areas of pigmented fibrosis (Figure 8).

Chemical analysis of representative portions of pulmonary tissue disclosed a free silica content of less than 1.0% in the ash and 0.2% in the dry lung. Examination of the ash and dry lung under the polarizing microscope revealed many birefrigent nonopaque crystals which had the angles of extinction and the refractive index of quartz.

Natural and artificial graphites are a form of carbon, chemically the same as diamond, but physically as soft as talc. The natural product is formed in many ways and may be found in igneous or in metamorphic rock. Usually, it is accompanied by common rock forming minerals such as quartz, feldspar, kaolinite, mica, etc. The artificial product is produced by heating

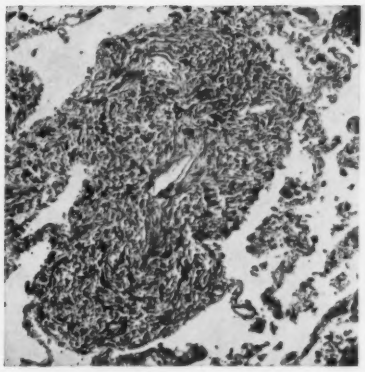
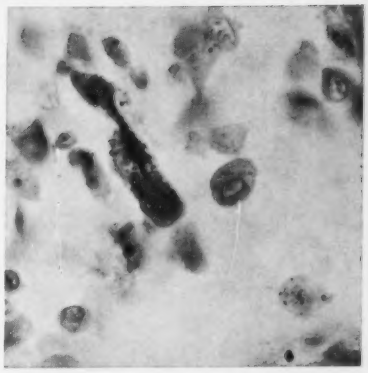


Figure 7
(Left) Focal lesion of pigmented fibrous tissue in the lung of worker, Figure 6.

Figure 8
(Right) Graphite body in the lung of worker, Figures 6 and 7.



coke in an electric furnace in the absence of oxygen. It has a wide variety of uses, such as for high purity electrodes and lubricants.

The case, presented above, was occupationally engaged with a variety of natural graphites derived from different world sources. Samples of those graphites were obtained in powdered form and they were chemically analyzed for graphite content by combustion analysis and for quartz content by x-ray diffraction quantitative techniques, using a fluoride standard. The graphite content ranged from 61.7 to 96.2% and the free silica (quartz) content from 1.56 to 19.9%. The artificial product was almost pure graphite with only 0.44% of quartz. In view of the above, the respective samples were tested by intratracheal injection into a series of albino rats. The artificial graphite acted only as an inert substance and failed to provoke any significant inflammatory reaction, even after residing in the lung for one year. In contrast, the natural graphites provoked a focal and diffuse chronic pneumonitis with the deposition of collagen and the development of hyalinized fibrous tissue. The severity and extent of that inflammatory response were directly proportional to the amount of free silica in the test sample.

These studies with respect to graphite are admittedly incomplete. They do, however, support the view that inhaled pure graphite dust is biologically inert, whereas natural graphite dust is biologically active in proportion to its free crystalline silica content. Whether the graphite component, per se, exerts an inhibiting or a stimulating influence on the effect of free silica, is still to be ascertained. In any event, the inhalation and pulmonary deposition of excessive quantities of natural graphite dust with its free crystalline silica component is productive of a focal and diffuse fibrogenic pneumoconiosis in both human and animal subjects.

The second case pertains to a white male whose occupational exposure to dust began when he was 29 years of age. At that time he became employed with the processing and handling of dusting powder for a variety of rubber products. After approximately 30 years of that work he began to develop a progressive shortness of breath. His chest x-ray at that time revealed a pronounced diffuse increase in linear markings, particularly in the lower portions of the upper lobes, bilaterally. Subsequently, he experienced a pneumonia which involved mainly the right upper lobe, but which ultimately resolved. His respiratory distress continued to progress and was ultimately attended by cyanosis and slight peripheral edema. Chest roentgenographic studies disclosed a diffuse infiltrative process throughout both lung fields, particularly the right upper lobe (Figure 9). Also, the lower lung field bilaterally revealed increased aeration, consistent with the diagnosis of advanced pulmonary emphysema. Death occurred approximately 20 months after that roentgen study.

At autopsy, his gross lungs showed a wide-

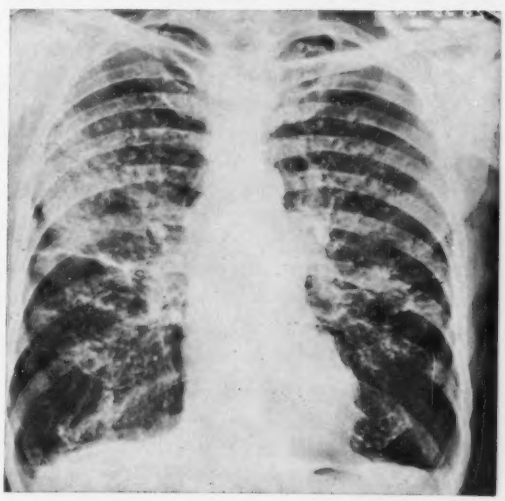


Figure 9
Chest roentgenogram exhibiting diffuse shadows of chronic proliferative pneumonitis in a mica worker.

Figure 10
(Left) Area of diffuse proliferative disease with scattered crystal structures as seen microscopically in lung of worker, Figure 9.

Figure 11
(Right) Identical area, Figure 10, but revealing the birefrigent crystals of mica.

spread pigmented fibrosis which was diffuse, but which had also fused to form irregular massive lesions that replaced large segments of the otherwise emphysematous lung. The tracheobronchial lymph nodes were mildly pigmented, but small and normally soft. There was no evidence of infection. Microscopic study confirmed the gross observations. In addition, however, the pigmented fibrotic tissue revealed numerous crystals which by x-ray diffraction analysis proved to be biotite mica (Figure 10). Under the polarizing scope, the crystals appeared long and narrow, often with internal parallel lines suggestive of laminar or plate-like structures, visualized obliquely (Figure 11). Most of the crystals had the optical properties of mica, but a few, presumably talc, could not be definitely excluded. Spectrographic analysis also disclosed the presence of small amounts of other substances such as magnesium, aluminum, iron, sodium and calcium. Free crystalline silica was not found.

In view of the above case, pure micas, both the biotite and muscovite varieties were respectively deposited in the lungs of a group of albino rats, via the intratracheal injection technique. Each mica initially provoked the focal development of a mild inflammatory reaction which was transitory and which had largely disappeared after one year. At that time, the intrapulmonary reaction was no more severe than the foreign body type of response to an inert dust.

With respect to the above case, it would appear that the diffuse pulmonary fibrosis resulted from the inhaled biotite mica. There is considerable uncertainty in that regard, however, and one cannot be certain whether other inhaled agents of his occupational environment may have been primarily, if not solely, responsible. That seems to be the case at least insofar that the limited experimental findings with albino rats indicate that mica is an inert substance.

Summary

The cases of diffuse pulmonary fibrosis which are frequently observed in association with a pneumoconiosis of occupational origin present a variety of problems which are in need of definitive and continued study. Certainly, not all dusts that are discovered in the lung at first glance are unequivocally responsible for the pulmonary disease which may be present.

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Theories of the Causes of Silicosis—part II

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Physical Theories

Whereas the name silicosis originated with Zenker (1866), the impact of this famous man is noticeable to this day whenever the angularity theory is fallaciously advanced to account for the pathogenic action of silica dust. This concept became quite popular after the optical microscope revealed the sharp edges and points of quartz particles. It was easy to imagine that these razor-edged and needle-sharp particles could penetrate and injure delicate pulmonary tissues. This angularity theory, was, however, effectively disproved by three pieces of evidence. First, it was shown by Gardner (1923) that carborundum particles, which are as angular as those of quartz, are inert when introduced into the lungs. Second, it became evident that while ferric oxide (Kettle, 1926) or aluminum hydroxide (Denny, Robson, and Irwin, 1937) can nullify the pathogenic action of quartz dust, they do this without changing the angular character of the quartz particles. Finally, the introduction of submicron amorphous synthetic free silicon dioxide dispelled any residual doubt about the factor of angularity. Several of these amorphous silicas possess an enhanced capacity to provoke pulmonary tissue reactions. Their particles are, however, completely spherical (Figure 11).

The suggestion that freshly fractured rock dust may be more pathogenic than old dust appears to have originated with Heffernan (1935). It is certainly true that freshly fractured quartz particles are chemically more reactive, combining readily with oxygen, water molecules, or other chemical agents. This very reactivity, if entirely chemical, may negate the biological action of the freshly fractured surface, since the surface forces will *a priori* be satisfied in transit to the lung through contact with oxygen and moisture of the air. Moreover, it has already been demonstrated that silicosis can be produced experimentally by aged dust (Gardner, 1932). Even the silica recovered from deceased silicotic subjects is fibrogenic. These observations rather effectively dispose of fresh fracturing of siliceous rock as a necessary factor in the genesis of the silicotic lesion. Heffernan's theory was meritorious, however, in that it focussed attention on the surface properties of

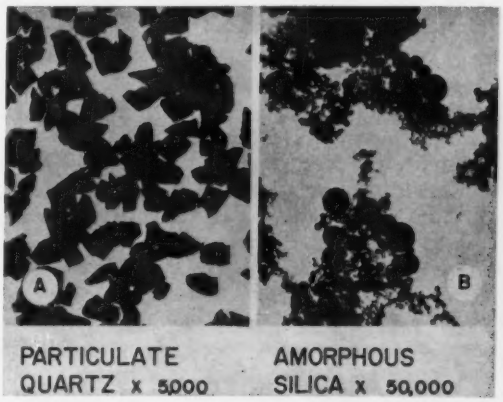


Figure 11

This is the second part of a three part article. Part I appeared in July, 1960. It was presented at the McIntyre Research Foundation Conference on Silicosis and Other Industrial Pulmonary Diseases, January 25-27, 1960, at Toronto, Canada.

the quartz particle rather than the chemical reactivity of dissolved silicic acid.

Perhaps one of the reasons why the surface action theory was slow in gaining recognition is that the science of physical chemistry is of relatively recent origin. The tremendous forces at the surfaces of particles have been measurable in recent decades only. Few pathologists are as yet thoroughly conversant with this eclectic discipline. Nor are all the surface forces relevant.

Piezo-electricity is a typical example. When Velicogna (1946) first suggested that quartz dust may be fibrogenic because of its piezo-electric properties, it seemed as if an explanation for silicosis was finally at hand. The concept was strongly championed by Evans and Zeit (1948, 1949). Once more, the logic was correct, but too few facts were taken cognizance of. Thus, it had already been established that tridymite, which is nonpiezo-electric, is several times more fibrogenic than quartz. Vitreous silica possesses no piezo-electric properties, but is moderately pathogenic. The converse also was provable. Thus, Policard (1950) demonstrated experimentally that wulfenite is highly piezo-electric, but incapable of provoking pulmonary fibrosis. Numerous piezo-electric substances with absent or low fibrogenicity have since been explored, e.g. tourmaline, barium titanite, aluminum orthophosphate (Pratt, *et al.*, 1953). Recent sporadic interest in this subject has been aroused through the discovery that cholesterol crystals are piezo-electric. It has been postulated that cholesterol in the atheromatous plaques of blood vessels may induce local fibrosis by virtue of the piezo-electric currents which may be set up when the crystals are strained by the distension and elastic recoil of pulsating blood vessels. Since cholesterol also accumulates in the lungs of silica-exposed subjects, piezo-electricity once more is relevant. In defense of the protagonists of the piezo-electric theory, it may be reserved that, although some nonpiezo-electric dusts have been shown to be fibrogenic and although other piezo-electric dusts exist which are not injurious to tissues, no one has yet conclusively disproved that in those cases in which piezo-electric particles are biologically active, the piezo-electricity can be wholly excluded as a pathogenic factor.

The negative charge at the surface of the quartz particle has been suggested by Hounam (1952) as one of the factors facilitating interaction with presumably positively charged protoplasmic constituents. Hounam explored various dusts for their charge, using methylene blue as the indicator for negativity, and Biebrich scarlet to mensurate positivity. Most pathogenic dusts appeared to carry a negative charge in proportion to their biological activity, while a positive charge characterized the more or less inert dusts. Since many proteins carry a positive charge, it has been assumed that the negatively charged particles are the more reactive. A fallacy in this concept resides in the fact that the negatively charged particles first make contact not with collagen precursors, but with cell cytoplasm which is negatively charged, e.g., macrophage, neutrophilic, polymorphonuclear leukocytes. It should also be recalled that in the split molecule of SiO_2, only the O^- radicle is negatively charged while the segregated Si^+ radicle is positively charged. However, it has not yet been disproved that the charge of the disrupted surface silica molecules may be a factor in the chain of reactions which lead to progressive silicosis.

During recent years, King and coworkers have explored many properties of fibrogenic dusts in an effort to identify the critical pathogenic factor. One of these, which received serious consideration, is the crystallinity of quartz (1953). A fruitful avenue of exploration was found in the thermal metamorphosis of quartz through tridymite, cristobalite to silica fume, vitreous silica and silica sublimate. One of the interesting discoveries along these lines has been the demonstration that α $AlPO_4$ has an x-ray diffraction pattern closely similar to that of tridymite and is about equally fibrogenic. On the other hand, aluminum oxide (other than the α Al_2O_3) and colloidal aluminum hydroxide (other than α AlOOH) are inert when introduced into tissues. These observations merit further systematic exploration. While a certain critical range of crystalline patterns may correlate with pathogenicity of dusts, it is also established that several noncrystalline silicas are fibrogenic. Vitreous silica is a typical example. Several of the submicron amorphous silica compounds which are entirely noncrystalline are vigorously pathogenic, while others are not. Crystallinity per se is not, therefore, the all-embracive factor though it may be relevant in the case of some siliceous dusts.

King's group also explored the role of particle size and defined a critically potent micron range for flint. Rather than being a new concept, this represents consolidation of observations originating with Mavrogordato (1918, 1922), Gardner (1928) and Van Wyk and Patterson (1940). Not only has it been shown that particle size influences the retention of inhaled dust, but the rate, degree, and character of the silicosis produced by quartz dust is most striking for particles in the 0.5 micron to two micron range. Particle size also governs such factors as migration of silica in the body, elimination or trapping of

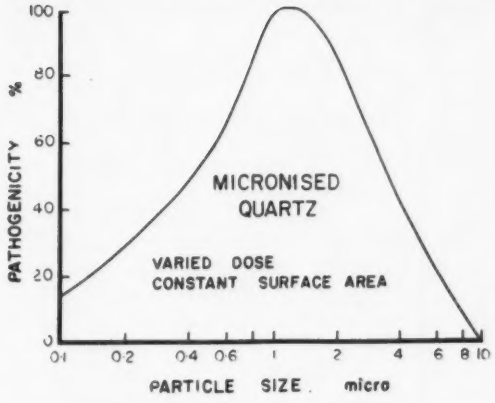


Figure 12

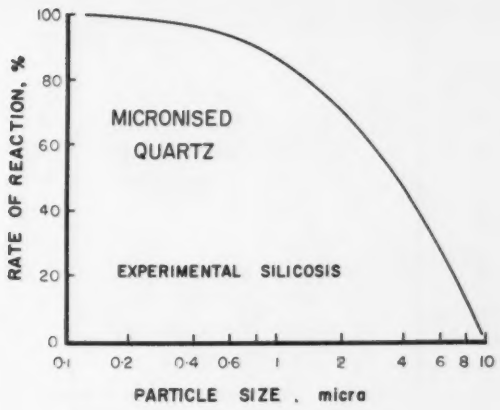


Figure 13

other dusts concurrently, previously or subsequently inhaled. The dose of micronized quartz of different particle sizes which is required to produce comparable lesions correlates inversely with the severity of the effect produced (Figure 12) and with the rate of its development (Figure 13). This is quite contrary to toxicity experiences.

Recently the suspicion has arisen that submicron siliceous particles are more potent as pathogens than are particles in the micron range (Jötten, *et al.*, 1954). This concept has been extended to apply to submicron particles of all dusts. It is certainly true that the quartz particles in silicotic tissue are generally less than three microns in diameter. Electron microscopy has demonstrated, in such tissue, an abundance of minute particles previously not suspected to be present. It is true too that certain fumed metals are toxic whereas these metals are inert as particulates. Of the submicron amorphous silica series, some of the smaller sized particles are highly injurious. However, pathogenicity is not yet an inverse function of particle size since some of the very smallest particles, e.g., silica sublimate (about 20° A) are comparatively noninjurious while some of the larger synthetic submicron silica particle (ca 200-400° A) provoke rapid and progressive pulmonary damage. These observations also hold true in the case of aluminum oxide. The very finely divided McIntyre aluminum powder is completely inert, whereas the particles of XH1010 (precipitated hydrated aluminum), which are considerably coarser, are highly fibrogenic. Particle size per se is, therefore, not the only etiologic factor, though relevant in particular mechanisms.

In many respects surface area correlates inversely with particle size so that what is true for the latter may hold for the former. The physical theories are much concerned with the question of surface area. It is, therefore, important to note to what extent surface area correlates with pathogenicity. Surface area of micronized quartz critically determines solubility (Figure 14). Experimental work of Dworski (1955) and of Zaidi, *et al.* (1956) has shown that there is a restricted surface area range which governs pathogenicity (Figure 15). Not only are lesions more severe within this surface area range but the lesions also develop more rapidly. This pathogenic range is confined to quartz particles with limited solubility. These observations have been confirmed by Nagelschmidt, *et al.* (1958). In the case of the submicron amorphous silica synthetic dusts, a somewhat modified specific relationship between

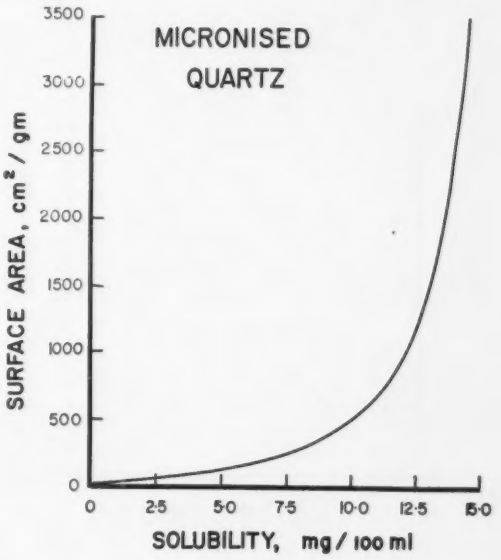


Figure 14

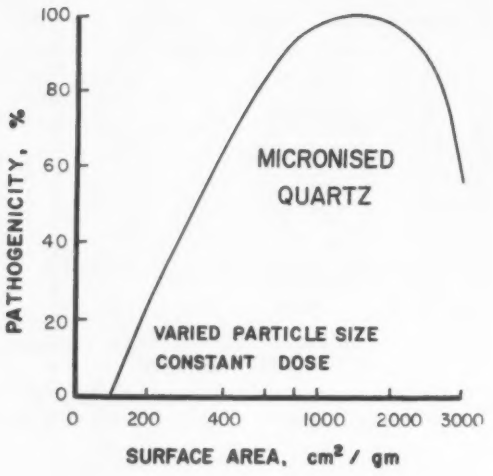


Figure 15

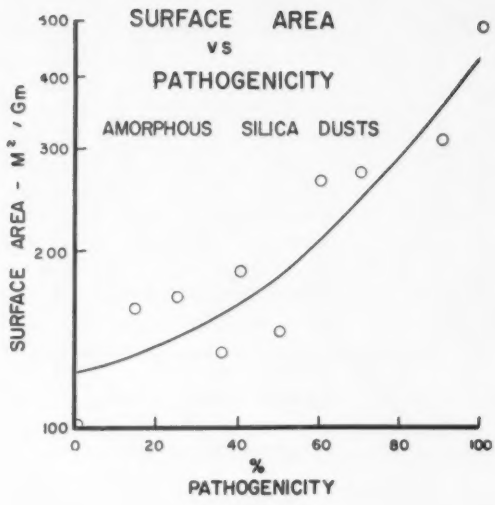


Figure 16

pathogenicity and surface area could be demonstrated (Schepers, 1960), but there are notable exceptions (Figure 16). While one of the most toxic materials has a high surface area ($491M_2$/gm), the silica with the next almost equally large surface area ($367M_2$/gm) is relatively inert. Again, one of the compounds with a B.E.T. surface area of 38 M_2/gm is relatively harmful, while most synthetic silicas in this surface area range are inert. Surface area per se, therefore, is not yet the factor in terms of which the pathogenic action of particulate silica can be expressed.

Particulate silica possesses variable potentialities for adsorbing onto other substances, particularly onto cations. This factor has been stressed by Iler (1955) as an important factor in the activity of silica as a physical agent and perhaps as a toxic substance. Iler makes the point that the greatest field of adsorptive forces surrounds the sharp edges and narrow corners of quartz particles. This adsorptive capacity has been explored as a biological force (Schepers, 1960) by comparing it with the pathogenicity of the subject dust (Figure 17). A strong correlation is apparent, suggesting the need for further inquiry along these lines. Pathogenic dusts are, however, not the only adsorptive agents. Thus, Kaolin and carborundum, which are comparatively inert, are strongly adsorptive for proteins.

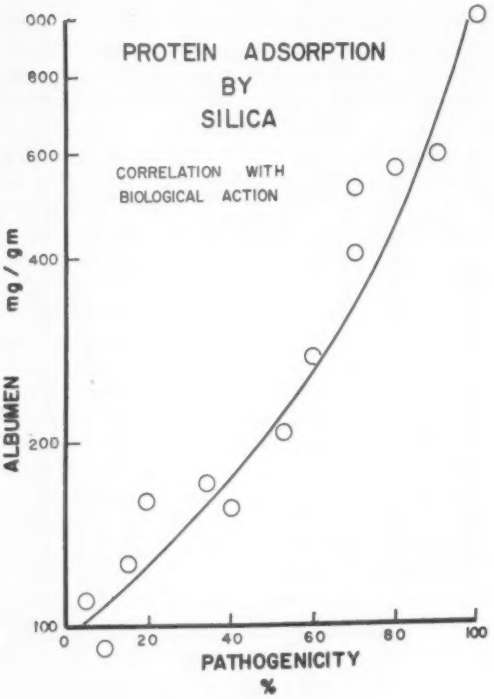


Figure 17

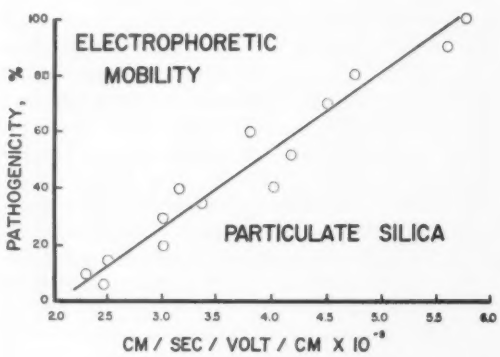


Figure 18

Since the surface of silica is probably, in part, the key to the problem, other forces at the surface have also been measured and compared with pathogenicity (Schepers, 1960). Two of these have offered some hope. The electrophoretic mobility (Figure 18) correlates more distinctly with pathogenicity than does the heat of wetting (Figure 19). The molecular density of silica also is relevant, particularly since it is a function of solubility (Figure 20). When the pathogenicity of varieties of silica is plotted against their molecular densities, however, the linear correlation with respect to solubility breaks down. Instead (Figure 21) it is evident that the main group of pathogenic silicas have a specific gravity between 2.1 and 2.8.

Biological Theories

Earlier speculations about the causation of silicosis emphasized principally the chemical and physical properties of minerals. There has, however, been progressive reorientation in favor of biological explanations, or, at least, recognition that the pathogenesis of silicosis reflects a synthesis of physicochemical and biological forces. In the sense that the silicotic nodule is something fabricated entirely by the living animal tissue, while the silica particle undergoes mini-

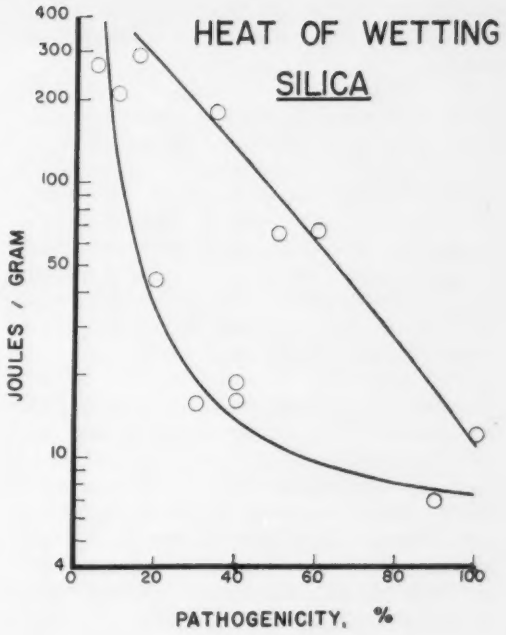


Figure 19

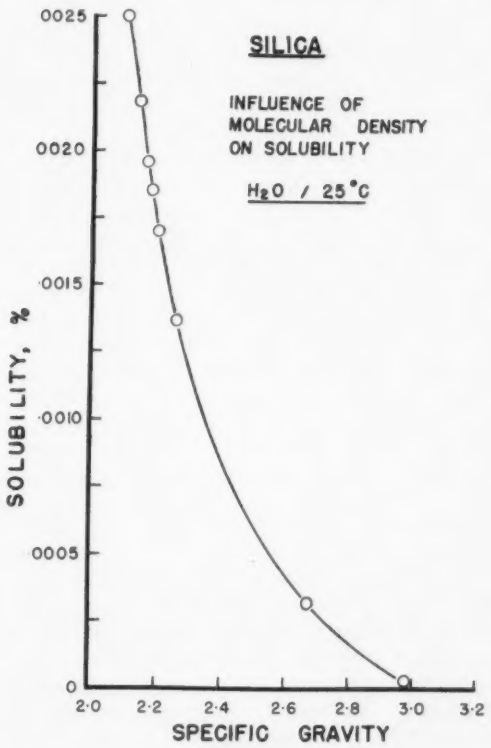


Figure 20

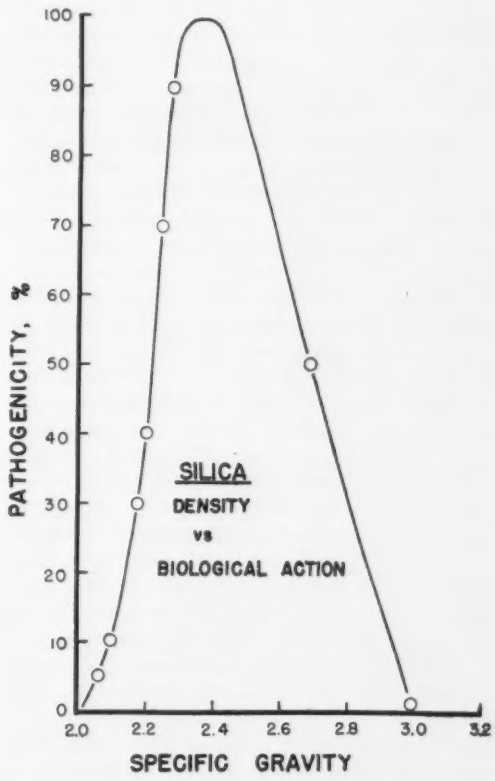


Figure 21

mal change, silicosis represents a biological process rather than a chemical or physical phenomenon.

The first specifically biological theory of any merit was that of Watkins-Pitchford (1915, 1928), who held that the development of the silicotic nodule depended on the presence of tuberculous infection in the lungs. This view is reminiscent of the original Miner's Phthisis concept of former centuries. Watkins-Pitchford did not, however, confuse tuberculosis with silicosis. Recognizing a clear-cut distinction, he nevertheless drew attention to the presence of viable tubercle bacilli in silicotic nodules recovered from lungs in which no overt evidence of tuberculosis could be demonstrated. What Watkins-Pitchford did not know, at that time, was that tubercle bacilli can be isolated from nonsilicotic pulmonary tissue in the absence of overt tuberculosis. Simson (1928) and Simson and Strachan (1931) later showed that silicotic nodules can be classified as either infected or non-infected. At the time Watkins-Pitchford worked on this problem virtually every South African miner died with, if not from, tuberculosis. After 1914, rigid pre-employment selection and periodical screening materially reduced the prevalence of tuberculosis. Silicosis, however, continued to disable and destroy uninfected men. Clearly, therefore, tuberculosis was not an essential ingredient. Gardner (1926) had also, meanwhile, successfully produced silicotic nodules in tuberculosis-free guinea pigs exposed only to quartz dust. Though tuberculous infection was eliminated as a cofactor in silicosis proper, studies on tuberculosis, tuberculosilicosis and silicotuberculosis yielded valuable clues. Some of the most significant recent discoveries have been that tuberculosilicosis can result from exposure to quartz dust: (a) prior to the development of silicotic lesions; (b) as a result of infection with typical or atypical Mycobacteria, which are avirulent for both experimental animals and human subjects in the absence of exposure to quartz dust. Typical examples have been the R1Rv bacillus identified by L. E. Trudeau almost 80 years ago and explored by Gardner (1930); the B.C.G. bacilli (Calmette-Guerin) so useful as a prophylactic vaccine against tuberculosis, but lethal for guinea pigs exposed to quartz dust (Policard, 1933); and the photochromogenic and achromogenic Mycobacteria which are avirulent for man or guinea pig unless there has been exposure to quartz dust (Schepers, 1958). These observations suggest rather forcibly that the inhalation of quartz dust induces biological reorganization of the pulmonary defenses against tubercle bacilli before silicotic lesions arise. The subtle biological reactions induced in the lung by inhaled SiO_2 are strictly confined to the zone of distribution of the silica particles. Thus, if the silica is inhaled, the tubercle bacilli evoke an enhanced response in the lungs and regional lymph nodes only, even if the tuberculous infection is subsequently introduced via the intratracheal, intravenous, intracardial, intraperitoneal or subcutaneous routes. By contrast, if the quartz particles are introduced by the intracardial route, the tuberculous response involves the liver, spleen and kidneys, where the silica particles become lodged. The Watkins-Pitchford concept had a final echo in the work of Sabin (1932) who showed that tubercles closely similar to silicotic nodules can be induced in experimental animals by introducing phospholipid extracts of killed mycobacterial capsules. We also have the current concept of Boeck's sarcoidosis caused by mycolic acid-like compounds derived from pine pollens.

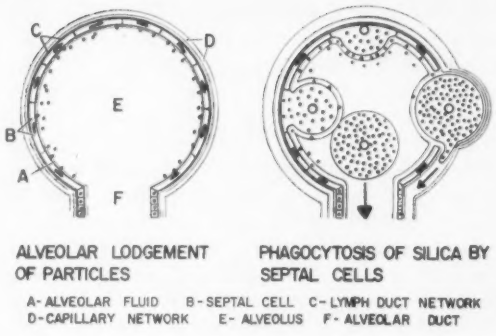
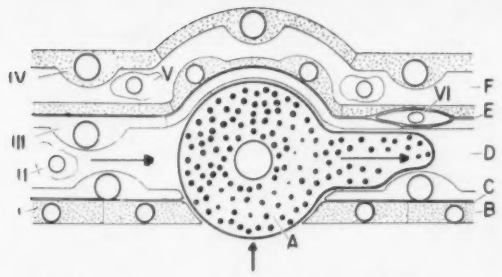


Figure 22

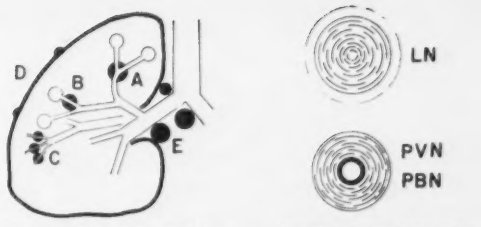
One of the essential discoveries favoring the biological interpretation of silicosis was the conclusive demonstration of the role of dust phagocytosis (Mavrogordato, 1918, 1922). Unless dust is first ingested by pulmonary koniophores, no silicosis follows. Mere phagocytosis is, however, not enough. The majority of the koniophores probably are floated out on the alveolar fluid stream and then expectorated (Figure 22). Only those dust-laden macrophages, which re-enter the pulmonary tissue, are important. The latter cells may be true histiocytes or blood-derived monocytes and thus have a natural aptitude to return to the pulmonary lymphatics, whereas the phagocytic alveolar epithelial cells, which normally are deciduous, will tend to be eliminated outwards. Whether the histiocytes enter the lung by penetrating directly into the alveolar wall or by entry into peribronchiolar lymphatics via special pores is not important. Once these dust-laden cells have penetrated the pulmonary lymphatics (Figure 23) they may be arrested in any location, though they tend to congregate in perivascular, peribronchiolar and lymphoid



KONIOPHORE ENTERS LYMPH SINUS

SOURCES OF PHAGOCYTES	ALVEOLAR WALL
- SEPTAL CELLS	A- KONIOPHORE
II - LYMPH MONOCYTE	B- ALVEOLAR EPITHELIUM
III - LYMPH ENDOTHELIUM	C- RETRO-EPITHELIAL SPACE
IV - CAPILLARY "	D- LYMPH SINUS
V - BLOOD MONOCYTE	E- SINUS-CAPILLARY SPACE
VI HISTIOCYTE	F VASCULAR CAPILLARY

Figure 23



DISTRIBUTION OF LESIONS

A-LYMPH FOLLICLE
B-PERIBRONCHIOLAR
C-PERIARTERIOLAR
D-PLEURAL E-HILAR NODES

VARIETIES OF NODULES

LN- LYMPHATIC NODULE
PVN-PERIVASCULAR NODULE
PBN-PERIBRONCHIOLAR

Figure 24

centers (Figure 24). Mavrogordato noted that these cells become "mummified," i.e., die without undergoing dissolution. Before this stage is reached, a spectacular array of cytobiological reactions occur. This can be well recognized in time-lapse microcinematographs of histiocytes studied in a phase negative optical system. It should also be stressed that, although various cells react to silica particles in different ways, only the histiocytes do ingest them. Leukocytes, particularly eosinophilic cells, are destroyed at a distance, i.e., before they are able to engulf quartz particles (Schepers, 1955). Local circulatory and enzymatic changes accompany this process. Without phagocytosis, however, they are meaningless. This is the point at which Kettle was misled when conducting his collodion bag experiment. The tissue reactions produced adjacent to the silica-filled bag were nonspecific inflammatory responses, probably induced by silicic acid. But these reactions did not progress to typical silicotic granulomatosis or fibrosis. Even the repetitive daily injection of silicic acid into the same subcutaneous site will not produce more than transient inflammatory responses. When quartz particles are introduced in sufficient quantity (minimum 0.1 mg locally implanted), a characteristic silicotic granuloma forms. In this lesion macrophage phagocytosis is an essential feature.

Once the quartz particle has been ingested by the phagocyte, its specific forces commence to act on the cell cytoplasm. Here there may be residual scope for the solubility theory. Policard (1933) championed the concept that quartz particles exert their deleterious effects through intracytoplasmic solubilization. It has also been suggested that polymeric silica may be formed within the cell cytoplasm. Unfortunately for this theory, phagocytosis stops after a satiation point is reached and the phagocyte migrates out of the pulmonary tissue. At a remote point it becomes immobilized and eventually, after a "mummified" phase, undergoes autolysis. The debris is mopped up by new macrophages. These, in turn, undergo the changes seen in the first cohort of histiocytes. This cycle is repeated apparently ad infinitum, but ever more slowly. It is limited only by encircling fibrosis and focal ischemia.

While the changes wrought in the cell by the ingested quartz particles suggested a process of intracytoplasmic solubilization to those who incline to chemical theories, such solubilization has not been certainly proved (Wheatley, 1957) and, if it occurs, may not even be relevant, having regard to the strong evidence in favor of physical theories.

Since collagen formation in most granulomatous processes is characterized by fibroblast proliferation pari passu with phagocytosis, a relationship between the two types of cells has been sought. It has even been suggested that macrophages can transform into fibrocytes. In tissue cultures fibrocytes sometimes emerge as the final cell type, whereas at the start the culture may have been of a different cell population. This may, of course, simply imply that the fibrocyte is the more durable cell, or even that the fibrocyte benefits from the death and dissolution of other cells. It is certainly remarkable that the dust-laden macrophages in pulmonary tissue persist as macrophages long after dust inhalation has ceased. It is also true that dust particles have never been demonstrated within the fibrocyte or fibroblast. This rather suggests that any theory of silicosis, which is based on the assumption that macrophages can transform into fibroblasts, is probably incorrect. It is possible that macrophages may assist in the formation of collagen deposits, or in the precipitation of collagen-like substances. Within the alveolar space, the macrophages filled with siliceous particles are sometimes cemented together by a substance

which has the histochemical staining properties of collagen (Schepers, 1957). Ordinarily, silicotic fibrosis does not take place in the absence of fibroblasts. Proliferation of fibroblasts is, therefore, as Wolbach (1933) suggested, a key to the development of the collagen deposits characterizing silicosis. In pneumoconiotic states which are not accompanied by fibroblast proliferation, little collagen forms and no nodules appear. The fibroblast is clearly a secondary invader as can be shown in serial biopsies of silicotic lesions developing after subcutaneous implantation of quartz particles (Schepers, 1955). What causes the fibroblast to appear on the scene remains a mystery. Silica per se exerts no chemotactic influence on fibroblasts in tissue cultures. The role of the fibroblast in forming collagen also needs further clarification.

During 1934, Strachan suggested that the silicotic nodule originates after the quartz particles become lodged within intrapulmonary lymph follicles. Peculiar distribution of the silicotic process, which developed in a miner with status lymphaticus, (Simson and Strachan, 1931) suggested this theory. It had already been shown that silicosis develops strongly not only in the regional pulmonary and tracheobronchial lymph nodes, but may follow the lymphatic chains down to the porta hepatis or even the groins or up into the cervical series. This is particularly the case if there is associated tuberculous infection. There is no doubt that silica is a lymphoid tissue seeker. The progressive accumulation of quartz in the regional lymph nodes has been demonstrated repeatedly, both in man and in experimental animals. Indeed, the silicotic granuloma not infrequently arises here first. However, this localization of lymph follicles may not be a property of silica per se. Many inhaled substances find their way into the lymphoid tissue. The carrier of the dust particles, namely, the macrophage, is the agent which seeks out the lymphoid follicles. The point that is relevant is that the quartz-laden cells are arrested here long enough to evoke an efflorescent reaction. These observations suggest that there is a peculiar relationship between lymphoid tissue and SiO_2. The lymphatic theory, however, goes further. Thus, it is known that the normal route of lymphatic drainage of the lung is outward to the pleura along the veins, and thence along subpleural channels to the hilar lymph nodes. Every connoisseur of silicosis knows that, during an early stage in human and experimental silicosis, the pleura undergoes extensive sclerosis with the development of pleural plaques. These obstructions deviate the lymphatic flow which eventually passes in the reverse direction to the hilar nodes. This blockage of the lymphatic

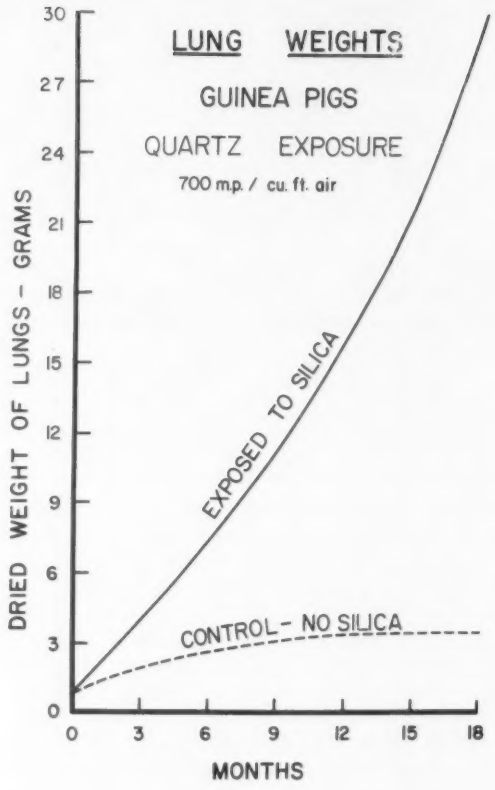


Figure 25

pathways was considered by Strachan as an important determinant of the development of pulmonary silicosis. Gardner supported this interpretation, believing that the lymphatic blockage enabled the local accumulation of SiO_2 in the lung until it reaches critical concentrations. Perhaps this is all there is to the matter. The logic is inescapable, that reversal and impairment of the lymphatic drainage of the lung may cause the local damming up not only of the inhaled silica but also of other metabolic substances which ordinarily are carried out of the lung by the lymphatic channels. These may include lipids, heparin, glycuronic acid and other liver-derived substances, and also toxic breakdown products liberated from cellular reactions to ingested SiO_2. The progressive arrest of these substances in the lung may be factors which favor the development of collagen formation.

It is the possible pulmonary entrapment of all these substances which accounts for the remarkable increase in the weights of the lungs of subjects exposed to silica dust. As shown in Figure 25, the lung of guinea pigs increases about 30 times in weight during 18 months of exposure to quartz dust. This gravimetric increment is not due to any significant extent to

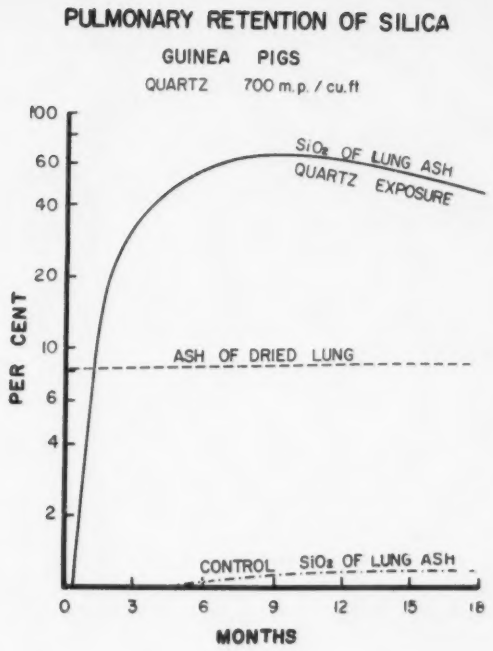


Figure 26

the accumulation of the silica per se. The total amount of silica retained is less than 60% of the lung ash and the ash of the dried lung remains more or less constant at between 8% and 9% (Figure 26). The maximum amount of silica retained also accumulates within the first six months of exposure, whereas the lung weight continues to increase thereafter.

Although the collagen in the lung increases more or less in parallel with the overall increase of the lung weight (Figure 27), this component attains maximum levels of between 200 and 300 milligrams only; whereas the dried weight of the lung increases from about one gram to over 30 grams during the same period. The accumulation of pulmonary lipid actually accounts for somewhat more of the increase of the lung weight since pulmonary lipid levels in excess of 1800 milligrams build up in experimental animals during 18 months of exposure to quartz dust (Figure 28). The remainder of the lung weight increase is to be explained on the basis of cell infiltrations and the accompanying mineral elements.

The role of lipids in pathogenesis of many disorders is presently under scrutiny. It is, therefore, of interest that a lipid theory for silicosis has also been considered. Fallon (1937) suggested that when quartz-engorged koniophores die, phospholipids are released. These lipids then provoke local fibrosis in the same way that the phospholipids in the waxy capsule of the tubercle bacillus causes a local granuloma.

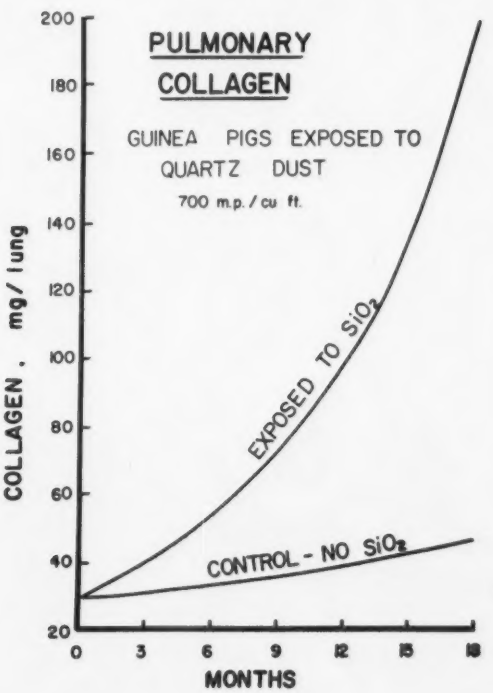


Figure 27

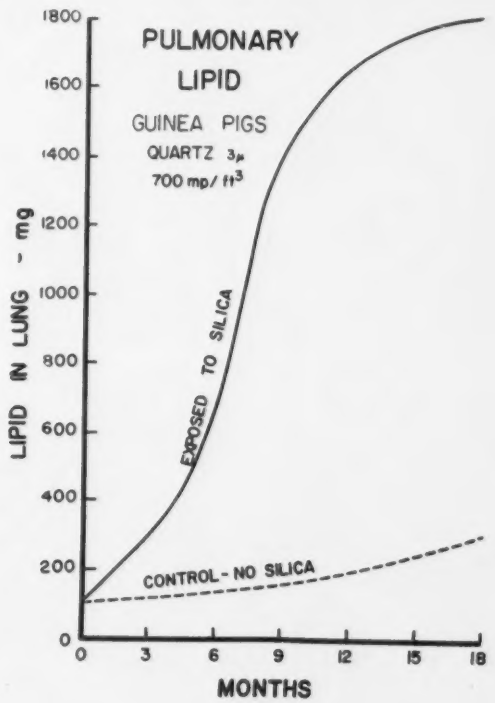


Figure 28

Proof for the latter contention was originally demonstrated by Sabin (1932). The presence of lipids in silicotic tissue was first discovered by Strachan and Simson (1931), who showed that the amount of pulmonary lipid increases pari passu with the severity of silicosis in rock miners. Fallon confirmed this by intracheal injections of quartz into rabbits. Moreover, he showed that phospholipids recovered from the lungs of these rabbits can excite peritoneal granulomata. Marks and Marasas (1960) have recently shown that not only the phospholipids, but also lecithin, cholesterol and free cholesterol increase in parallel with the accumulation of SiO_2 and collagen in the guinea pig lung, but not in the rabbit. It is important to note that the lipid increases were most marked terminally. In the rabbit the lecithin also increased without associated increase in pulmonary collagen. These observations, therefore, suggest that the increase of pulmonary lipid is an effect of the progressive evolution of the pulmonary silicosis and not a cause.

In experiments with submicron amorphous silica, with beryllium salts (Schepers, 1956, 1957), and with antimony trioxide (Gross, *et al.*, 1952), it has also been possible to demonstrate the progressive accumulation of lipids within pulmonary macrophages. While lipid storage has been suspected as a factor in the elaboration of the granuloma of berylliosis, the lipid in the lungs of guinea pigs exposed to the submicron amorphous silica accumulates within intra-alveolar macrophages, i.e., not at the sites of granuloma formation. Silica can combine with alpha monostearin yielding glyceride orthosilicic esters (Klein and Nienburg, 1936). Quartz also has an adsorptive influence on cholesterol (Holzapfel, 1949). Certain lipids artificially introduced into the lung are capable of producing extensive fibrosis (Schepers, 1960). The role of lipids can not, therefore, be dismissed as factors in the etiology of component phases of the silicotic lesion. Their precise overall role remains to be elucidated.

The phenomenon of silica shock first described by Modell (1941) sheds further light on the pathogenesis of silicosis. When 1-3 μ quartz particles, appropriately suspended, are injected intracardially in small doses, no adverse reaction follows. On repeated administration of SiO_2 in this manner, silicotic lesions will form in the lymphoid follicles of the liver, spleen, and kidney. If the dose of SiO_2 is stepped up, (e.g. 40 mg/kg for a guinea pig) the animal becomes markedly shocked and dies within a few seconds to minutes. At necropsy there first is universal hyperemia and then marked ischemia of all viscera. This is a purely vasomotor phenomenon. No silica is recoverable from the blood at the moment of death. This silica shock can be completely prevented by steeping the quartz particles in a dilute solution of colloidal aluminum hydroxide (e.g. 1:500 ratio) or adding a small quantity of finely pulverized aluminum oxide to the quartz particles (e.g. 1:100 ratio) immediately before injecting the quartz suspension (Schepers and Delahant, 1960). The aluminum disappears from the circulation quite promptly. All that the $Al_2(OH)_3$ can do in such a short while, to neutralize the SiO_2, is to coat the quartz particles. The mystery of the disappearance of the silica and aluminum needs clarification. Perhaps these substances are trapped by the vascular endothelium. Quite possibly the lymphatic system once more is the garbage heap.

The tremendous circulatory disturbance observed in silica shock experiments directs attention to the role of the vascular system in silicosis. To Cole (1948) goes much of the credit for demonstrating the extensive involvement of blood vessels in silicotic tissue. This process has been further elucidated by others (Lavenne, 1951 and Schepers, 1955). This injury is more extensive if the exposure has been to mixtures of quartz with other minerals. The smaller arterioles become enveloped in concentric fibrotic sleeves. These collagenous cuffs expand regionally to form distinct nodules and occlude and incarcerate the blood vessels (Figure 24). Cole evolved the view that ateriolar obstruction is not only one of the most important features of silicosis (a view strongly supported, Schepers, 1957, 1959), but that the attendant tissue ischemia is relevant to the development of silicotic scar tissue.

That vascular occlusion is an early feature of silicotic damage is easily demonstrated in experimental animals by preparing colored plastic casts of the pulmonary arterial and venous arborizations. As exposure to silica dust continues, the smaller arterioles progressively drop out. This occurs before silicotic nodules are demonstrable. There is no doubt about the progressive impairment of pulmonary circulation, which is later reflected in pulmonary hypertension and cor pulmonale. First there is impaired blood supply. Later, bronchopulmonary vascular anastomoses are effected so that the lung becomes regionally supplied with arterial blood. It has not yet been clarified whether silicosis develops the more rapidly in the ischemic lung or whether local arterial dominance favors fibrogenesis. Fibrosed bronchiectatic lungs possess abundant arterial blood supply. It is not unlikely that local circulatory impairment will deprive the lung substance of essential nutriments or liver-derived metabolites (e.g. heparin, hyaluronic acid, glucuronic

acid, gamma globulin, etc.) which prevent fibrosis in the normal lung.

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The Cyborgs

Dr. Nathan S. Kline and Dr. Manfred E. Clynes of the Rockland State Hospital research facility at Orangeburg, N. Y. think the bodies of men may have to be altered chemically and electronically to enable them to travel through the bleakness and perils of outer space to other planets. The altered human beings they think may be necessary for space flights would be called "cyborgs."

Man is made for comfortable living in an earthly environment. A cyborg could be scientifically adapted to the environment of outer space. A cyborg would have no problem of oxygen regeneration in his space cabin, since he would not have to breathe. A "lung" powered by a solar battery and attached to his arteries would remove carbon dioxide from his blood and replace it with oxygen.

At a May, 1960, symposium on the psychophysical aspects of space flight sponsored by the U. S. Air Force, Kline and Clynes said the rose osmotic pump inserted in the cyborg's body might be used to cause near hibernation and permit him to tolerate the long, tedious journeys to other planets.

The cyborg, according to Kline and Clynes, might not have to worry about food. It is theoretically possible to process urine and pass the nutrients in it back into his blood stream, thus preserving his fluid balance.

If a cyborg's bodily functions can thus be changed, Kline and Clynes think he almost might be made artificially happy. The pleasure centers of his brain might be electrically stimulated at intervals.

If the cyborg were not already ready for long periods of hibernation, he could be put to sleep by drugs or an electrical device. Kline and Clynes said they already have experimented with a Russian device, the electroson, which can induce sleep and produce wakefulness. They think this instrument will prove valuable to the astronaut during the tremendous stresses that are produced upon his body by a rocket's blastoff.

Kline and Clynes think the cyborg idea might also be adapted to the conquest of mental and other diseases. —From *Miami* (Fla.) *Herald*, May 23, 1960.

Pulmonary Function Studies

In Diatomaceous Earth Workers

2. A Cross Section Survey of 98 Workers on the Job

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Pulmonary function studies have been obtained on 98 workers representing a cross section of the diatomite industry. The workers were selected through the cooperation of the United States Public Health Service as part of a full scale investigation of the diatomite industry in 1953-54; a survey that included environmental studies of the plants as well as the clinical and roentgenologic examination of all employees.[1] The pulmonary function measurements were obtained on a group selected to provide a representative cross section of the men on the job, with respect to age, chest roentgenogram appearance, and the type and the length of work in this industry. At the start of this study a group of 150 was selected, as it was physically impossible to study all of the diatomite workers of the Public Health Service Survey, where, in one plant alone, over 500 workers had been examined. There were no changes in the original group and the study was on a voluntary basis for the workers. Complete pulmonary function studies were obtained on 98 of the original group of 150 cases selected; the other workers either failed to come in for the function studies or changed employment.

Interest in lung function changes which may be induced by exposure to diatomaceous earth has been stimulated by a number of observations previously reported for this new form of pneumoconiosis.[2,3] Total disability has been reported from this laboratory in diatomite workers based on pulmonary function measurements.[4] When the crude diatomaceous earth is heated, crystalline cristobalite is formed from the amorphous silicon dioxide, a silicosis producing substance, and capable of producing disabling pneumoconiosis. The investigations to date of pneumoconiosis in diatomite workers have been limited almost entirely to the clinical and roentgenological aspects, except for two published reports.[1,4] Some animal experimentation has been carried out at the Saranac Laboratory at Saranac Lake, New York.[5] The clinical and roentgenological aspects of diatomite pneumoconiosis appear to differ from those noted in coal miners in a number of respects. The rapid onset of severe disability (three to five years) occurring in several workers was quite striking[4] as compared to the longer period of time usually observed in coal miners (15 to 20 years or longer). The linear changes on the chest roentgenogram of the diatomite worker are more characteristic findings[3] than those noted in coal miners' pneumoconiosis or hard rock miners, where discrete nodulations are observed more consistently. Rapid, progressive pulmonary fibrosis with coalescence and with severe disability has been noted in workers exposed to calcined and flux calcine powders and without evidence of tuberculosis infection.

Lung function has been evaluated in this study by a battery of physiological tests,[6] which have been shown to have a wide range between the normal and abnormal. These tests provide reliable criteria on the ability of the individual adequately to get oxygen in and carbon dioxide out, both during rest and exercise. The physiological data on the group of 98 cases has been obtained over a three year period. This group represents a unique study in that the subjects who have been selected by the Public Health Service[1] on a basis of their survey provide a representation of the industry as a whole.

Methods

Spirogram recordings were obtained on the 13.5 liter Collins respirometer, to determine the total vital capacity, the timed vital capacity for three seconds and the maximal breathing capac-

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ity, and these measurements were repeated after a bronchodilator treatment to evaluate bronchospasm if present. The residual air was measured and checked both by the oxygen open circuit and the improved helium closed circuit methods.[7] All lung volume measurements are expressed at body temperature, ambient barometric pressure and saturated (BTPS). The arterial blood samples were obtained from an indwelling Cournand type needle in the brachial artery, both at rest and with step-up and treadmill exercise. The oxygen content, oxygen capacity, and carbon dioxide content were obtained on resting and exercise samples of the arterial blood, employing the manometric Van Slyke apparatus. The arterial blood oxygen saturation was determined both from oxygen content and capacity measurements and by employing the Waters double-scale cuvette oximeter for whole blood. The oxygen capacity was checked both by the flask and Van Slyke methods. If hypoxia was present additional arterial blood samples were obtained with the subject breathing on graded levels of high oxygen breathing (32% to 40% oxygen) and 99.6% oxygen and with intermittent positive pressure breathing on compressed air only. The subject was allowed to breathe the high oxygen mixture for eight to 10 minutes before the exercise was started. The pH of the arterial blood was measured on the Cambridge glass electrode. The arterial pCO_2 and pO_2 were determined by the direct tension method using the bubble technique.[8] The pulmonary ventilation measurements were obtained from gas analysis on samples of the expired air collected in a Tissot gasometer using the Scholander gas analyzer. The minute ventilation, oxygen uptake and carbon dioxide output were expressed at standard temperature and pressure (STP). The exercise tests consisted of stepping up and down 30 times on a stool 20 cm high in one minute, and walking on a treadmill at two miles per hour flat. The effective tidal air was calculated from the expired pCO_2 (based on Scholander gas analysis) and the arterial pCO_2 (by the direct bubble tension measurement).[9]

Material for Study

The 98 volunteer subjects in the survey group were all employees of the diatomite industry and working at the time of the study. They were selected as a part of the routine survey as previously described to provide objective quantitative measurements for use in evaluating the health hazard in the industry. All of the chest roentgenograms were classified on a basis of abnormal linear (L), nodular (N), and confluent (C) opacities, grading each in terms of the area of lung involved on a scale of one through four, according to the plan adopted in the survey by the United States Public Health Service.[1] The United States Public Health Service interpretation was used for all roentgenograms of the survey cases. The linear and nodular changes were grouped together (LN) and the classification was simplified as indicated below:

LN_1 Suspicious for linear-nodular changes.

LN_2 Definitely abnormal linear changes, nodular changes, or both, involving an area less than the equivalent of two quadrants of the lung field.

LN_3 Linear changes, nodular changes, or both, involving more than one-half of the total lung area or extending to or nearly to the periphery of both lung fields bilaterally.

C_1 Confluent shadows of uncertain or ambiguous significance, superimposed on any of the foregoing.

C_2 Massive confluent opacities definitely present, extending over less than the equivalent of three anterior rib spaces on either side.

C_3 Massive confluent opacities definitely present, extending over the equivalent of three or more anterior rib spaces on either side.

C_4 Massive confluent opacitites, associated with gross distortion of the pulmonary anatomy.

The graphic representation of the data shown on the charts in this paper correlating the roentgenologic appearance of the chest with the function measurements was prepared as follows: the number of dots attached below the circle for each case indicates the stage of nodularity (1, 2 or 3), and the number of dots above the degree of conglomerate changes (1 or 2). The open circles indicate negative x-rays.

Results

The exposure time in the plant as to location (quarry, mill or other) was correlated with the x-ray classification and the number and exposure time in years for the workers, in Table I. The largest number of workers were from the mill, and in this group those with nodular-confluent x-ray changes had a significant longer exposure time in years than the negative x-ray group. Workers at the quarry and in other places ex-

TABLE I.
EXPOSURE TIME IN PLANT

X-Ray Classification	QUARRY		MILL		OTHER	
	Number of Workers	Average Time Years	Number of Workers	Average Time Years	Number of Workers	Average Time Years
Negative	0.0	0.0	19.0	5.7	22.0	7.4
Linear-Nodular	14.0	8.8	29.0	8.8	5.0	5.6
Nodular-Confluent	5.0	17.0	23.0	9.3	7.0	14.6

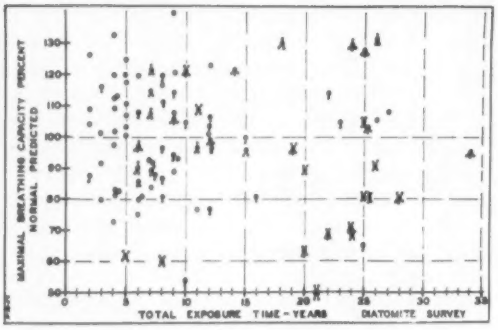

Figure 1

Correlation of the total exposure time in years in the diatomite industry on the abscissa, with the maximal breathing capacity as percent of predicted normal on the ordinate in the 98 diatomite workers. The number of dots below the circle indicates the stage of nodularity on the x-ray (1, 2 or 3), and the number of dots above the circle the degree of confluent change (1 or 2). The open circles indicate negative x-rays.

cept at the mill with nodular-confluent x-ray changes also had a longer average time of work in the diatomite industry. Thus, in the three groups of workers studied at the diatomite plant, those with negative x-rays had the shortest average time of exposure in years, the nodular-confluent group the longest exposure time in years, and the exposure time was intermediate for those with linear-nodular changes.

The maximal breathing capacity (MBC) measurement was correlated with the x-ray appearance and total exposure time in years (Figure 1). The MBC was markedly decreased in only three subjects (60% or below). The MBC was 100% or more of the predicted normal in 48 of the workers and 23 of these had either linear-nodular or nodular-conglomerate changes (Figure 1). There was no correlation of the total exposure time with the MBC.

The residual air as percent of the normal predicted volume was correlated with the ratio of the residual air to total lung capacity (Figure 2). In 29 cases there was a moderate increase in the absolute volume of the residual air (volume of residual air 120% to 160% of predicted normal) and this represents a significant abnormality. In 12 cases there was a moderate decrease in the absolute volume of the residual air (volume of residual air less than 80% of predicted normal) and this suggests the possibility of a restrictive condition of the lung characteristic of fibrosis. The absolute volume of the residual air was markedly increased (above 160% of normal predicted) in 10 cases, of which four were nodular-conglomerate, three nodular and three negative with respect to the x-ray appearance (Figure 2). The ratio of residual air to total lung capacity was greater than 35% in only nine cases, and in 13 cases the ratio was 30% to 35%. An increase in the residual air represents an early change of function impairment. As long as the total vital capacity is normal and the ratio of residual to total lung capacity less than 35%, compensation occurs for this increased volume and the individual may have no subjective complaints, because the breathing reserve normally present in the lung is large.

The ventilation factor as percent of predicted normal was correlated with age in years and

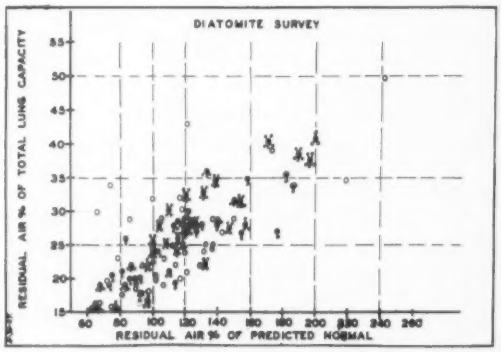

Figure 2

Correlation of the residual air as percent of predicted normal on the abscissa, with the residual percent of total lung capacity (residual plus vital capacity) on the ordinate. The x-ray stage of each subject is represented as in Figure 1.

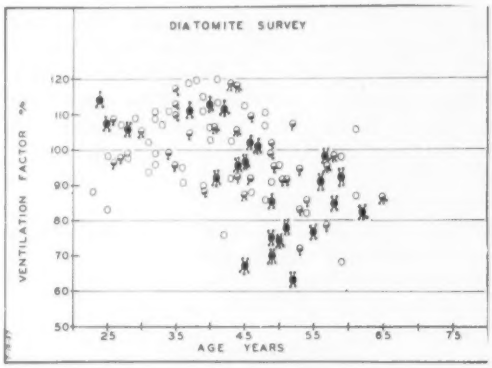

Figure 3

Correlation of the ventilation factor as percent of predicted normal with age in years and x-ray appearance. The x-ray stage is represented as in Figure 1. The ventilation factor represents the average of the timed vital capacity for three seconds, the maximal breathing capacity and the residual percent of total lung capacity, all expressed on a basis of the normal predicted value. The ventilation factor is a single figure value of the ability of the individual to use the chest and lungs as a bellows.

x-ray appearance in the 98 diatomite workers (Figure 3). If the ventilation factor is normal, breathing is adequate for carrying oxygen down to the alveolar level and carbon dioxide will be blown off. In 41 cases the ventilation factor was 100% or above the normal predicted values, and in 32 there was only a very slight decrease (not of a significant degree). The ventilation factor measurements indicate that in 73 of the 98 cases studied impairment in alveolar aeration was not a factor. In 14 cases the ventilation factor was decreased slightly (80% to 90%) and in 11 cases moderately (60% to 80%). Although

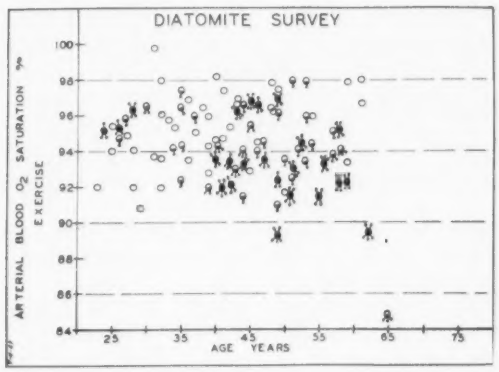

Figure 4

Correlation of step-up exercise arterial blood oxygen saturation with age in years and x-ray appearance. The individual cases are represented on the chart as described in Figure 1. The exercise arterial blood oxygen saturation on air breathing was above 90% in all of the cases except three.

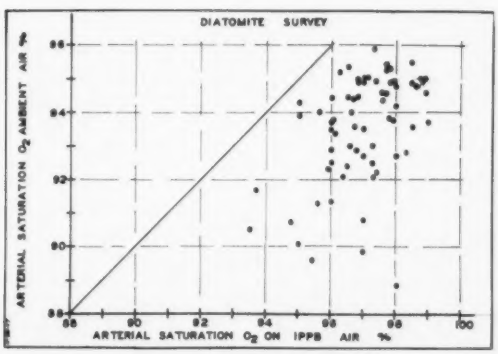

Figure 5

Correlation of the arterial blood oxygen saturation on ambient air breathing at rest in 68 cases with intermittent positive pressure breathing (IPPB) on compressed air. Note the increase in arterial blood oxygen saturation in all cases with the IPPB on compressed air, with the deeper breathing and increased tidal air provided by the respiratory assistance on inspiration.

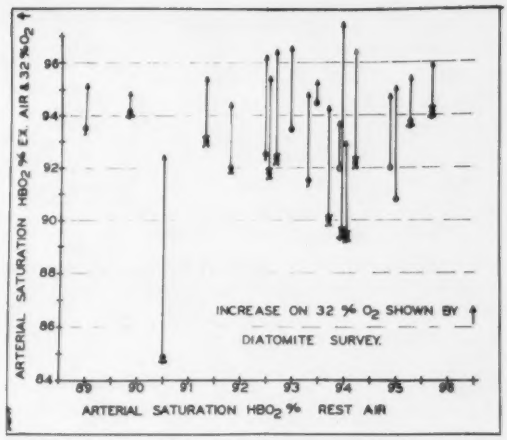

Figure 6

Correlation between the resting arterial blood oxygen saturation on air breathing on the abscissa and the arterial blood oxygen saturation with exercise on air breathing and 32% oxygen breathing on the ordinate. The increase in the saturation with exercise on 32% oxygen is represented by the arrow extending upward for each case. The x-ray stage is represented as in Figure 1.

seven of the 11 cases with a moderate decrease in the ventilation factor had nodular-confluent changes on the x-rays, there were 14 cases with a normal ventilation factor and nodular-confluent x-ray changes. There was no apparent correlation of the ventilation factor and the x-ray changes.

The arterial blood studies at rest in the diatomite workers reveals a significant reduction below the normal value of 96% in 62 of the cases. In 30 workers at rest there was a moderate decrease in the saturation ranging from 92% to 94%. However, in 54 subjects with exercise there was an increase in the saturation as compared to the resting saturation due to deeper breathing with a more uniform alveolar aeration. The exercise arterial blood oxygen saturation on air breathing was correlated with the x-ray change and the age in years (Figure 4). In three cases the exercise arterial blood oxygen saturation was less than 90%, and in six cases between 90% and 92%. In 31 cases with a normal exercise saturation of 96% or more, 17 had negative, nine had nodular and five had nodular-confluent x-ray changes. No significant correlation was noted between the exercise arterial blood oxygen saturation and the x-ray change with the age of the worker (Figure 4).

The arterial blood oxygen saturation was obtained on intermittent positive pressure breathing (provided by the Bennett unit) using compressed air in 68 subjects and compared to the values obtained at rest on ambient air breathing

(Figure 5). The arterial blood oxygen saturation was increased at rest in a slight to marked degree in all cases with intermittent positive pressure breathing (IPPB) on compressed air only. The arterial blood oxygen saturation in 58 of the above subjects was 96% or more on IPPB with compressed air, and these findings would indicate that the improvement in alveolar aeration provided by the mechanical respiratory assistance on inspiration was primarily responsible.

In 20 cases the arterial blood oxygen saturation with step-up exercise was determined on a graded level of high oxygen breathing (32% oxygen) and compared with the saturation obtained on air breathing with step-up exercise and at rest (Figure 6). The saturation was in the normal level (97% to 98%) in only one case, with the step-up exercise on the 32% oxygen breathing, and above 96% in only four cases. The normal value breathing 32% oxygen is 97% or more saturation of the arterial blood. The failure of the arterial blood oxygen saturation to increase to the normal value of 97% or more indicates the perfusion of some blood through nonventilated areas with the increased cardiac output of exercise. In the one case where the saturation was increased to 97%, a marked degree of bronchospasm was present. The 32% oxygen breathing increases the inspired pO_2 over 70 mm Hg and will correct for inequalities of ventilation such as may be present in severe bronchospasm. In these studies when hypoxia was present with exercise on air breathing the arterial saturation was not restored to normal on the graded level of high oxygen breathing (32% O_2) with the inspired pO_2 increased over 70 mm Hg as compared to air breathing. The use of graded levels of high oxygen breathing helps differentiate whether the primary significant factor producing hypoxia be an alveolar-capillary membrane block or the perfusion of blood through nonventilated areas at or near the capillary level.[10,11] As a result of the above type of study, an alveolar-capillary membrane block has not been found to be a significant factor in the production of hypoxia in diatomite pneumoconiosis. The decrease in arterial saturation when present during exercise represents primarily an increased blood flow through very poorly ventilated alveoli or nonventilated alveoli (the latter being little right to left shunts at the alveolar level) in diatomite pneumoconiosis. At rest the blood tends to perfuse the better ventilated and perfused areas of the lung with the lower cardiac output as compared to exercise. Thus hypoxia results primarily from the presence of poorly ventilated alveoli (the emphysema aspect) and the perfusion of blood through nonventilated areas (the fibrosis aspect) especially during exercise, a ventilation perfusion abnormality. The use of intermittent positive pressure breathing on compressed air only on those cases with unsaturation at rest produced a significant increase in the arterial saturation in all cases, indicating the presence of poorly ventilated alveoli as a major factor responsible for the decreased resting saturation. The arterial blood saturation measurements in those subjects with hypoxia in general are similar to studies obtained in a group of 20 cases with severe restrictive condition of the lung[11] (mostly from pulmonary fibrosis) where the exercise saturation was quite low even on 32% to 40% oxygen breathing mix-

TABLE II.
PULMONARY FUNCTION STUDIES ON DIATOMITE PNEUMOCONIOSIS

Group, based on X-Ray appearance & No. of cases	Negative 41		Linear-Nodular 33		Nodular-Conglomerate 24	
	Average	Range	Average	Range	Average	Range
Age, years	40.2	25-61	44.3	26-65	46.3	24-62
B.S.A. (Sq.M.)	1.91	1.66-2.26	1.90	1.62-2.19	1.87	1.68-2.07
Vital Capacity Supine, ml. Observed	4844	2660-6646	4480	2918-5616	4601	3480-5964
% Predicted	108.1	81.2-138.6	106.3	80.1-137.7	105.7	82.0-132.3
Timed Vital Capacity, 3 sec., ml. Observed.	4614	2498-6482	4172	2852-5771	4128	2753-6008
% Predicted	102.8	67.4-139.0	98.5	78.2-121.4	94.5	65.2-127.2
Maximal Breathing Capacity, L/min. Observed	150	82.6-228	140	78.4-222.1	128	51.5-201.5
% Predicted	107.9	71.5-141.8	99.1	54.3-132.8	91.8	60.1-132.4
Alveolar N_2 after 7 min. O_2, %	1.18	0.49-4.07	1.08	0.30-4.07	1.73	0.38-4.64
Residual Air, ml. Observed	1581	938-3852	1544	768-2822	1859	965-3012
% Predicted	115.7	26.8-242.3	112.9	61.4-185.7	130.3	77.0-200.6
Residual % Total Lung Capacity	24.3	17.2-49.4	25.2	15.3-36.2	28.6	15.7-40.8
Ventilation Factor %	100.8	68.3-122.8	98.7	71.8-119.2	91.9	63.3-114.4
Arterial Blood O_2 Sat. % Rest	95.1	89.6-98.1	94.2	89.8-98.5	94.5	91.3-97.2
Exercise	95.4	91.7-99.8	94.3	84.8-98.0	93.7	84.3-97.0
Arterial CO_2 Cont. Vol. % Rest	47.1	40.5-51.6	45.5	38.2-51.5	44.5	37.4-50.5
Exercise	45.6	38.6-51.4	44.8	38.5-49.4	43.6	39.1-50.4
Min. Vent. L./Sq.M./BSA. Rest	3.67	1.98-6.49	3.80	2.03-5.29	3.88	2.68-8.49
Exercise	12.92	6.66-22.16	12.60	6.56-19.10	11.38	7.04-21.12
Oxygen Uptake, ml/min/Sq.M./BSA. Rest	126	95-220	135	68-294	130	115-147
Exercise	520	333-893	540	316-714	488	221-710
Alv. Art. pO_2 Difference, Rest mmHg.	16.2	1.3-19.9	13.2	2.4-31.9	9.3	5.0-22.5
Effective Tidal Air, Rest, %	66.0	44.5-86.9	66.6	44.3-88.0	63.3	47.0-83.0

ture, providing an inspired pO_2 increased over 70 to 130 mm Hg, far more than adequate to overcome an alveolar-capillary membrane block if that were the primary significant factor producing the hypoxia.

The pulmonary function measurements in the 98 diatomite workers were tabulated in three groups (including the average and range) based on the x-ray appearance of the chest (Table II). There were 41 workers with negative, 33 with linear-nodular and 24 with nodular-conglomerate changes on the x-ray. Early pulmonary function changes in the diatomite workers' lung volumes consist of decreases in the timed vital capacity for three seconds and the maximal breathing capacity and an increase in the absolute volume of the residual air. There was a significant average decrease in the maximal breathing capacity percent of predicted in the nodular-conglomerate group as compared to the negative group. Also the average residual air percent of predicted normal was significantly increased in the nodular-conglomerate group as compared to the negative group. Impairment in air distribution was present in some cases in all groups as evidenced by the elevated alveolar nitrogen. The average rest and exercise arterial blood oxygen saturations and CO_2 contents were not too different in the three groups (Table II). The exercise oxygen uptake in the nodular-conglomerate groups was decreased significantly below that of the other two groups. The effective tidal air was decreased more in the nodular-conglomerate group. Although the average measurements of function revealed more severe impairment in the nodular-conglomerate group, the data presented in Table II reveals wide individual variations in all groups with significant impairment in function tests in individual cases in the negative x-ray group as well as the others. The range of the individual pulmonary function measurements was about the same in the three groups based on x-ray changes.

A comparison of step-up exercise with a steady state of treadmill exercise at the same study period was obtained in 37 of the diatomite workers (Table III). The treadmill was set at two miles per hour flat. The treadmill data revealed no significant difference in the arterial blood oxygen saturation, the CO_2 content or the pH as compared to step-up exercise, and the pulse rate, the respiratory rate, and the minute ventilation were not significantly altered on the average. The tidal air was consistently larger on the treadmill as compared to step-up exercise. The oxygen uptake and the CO_2 output were slightly larger with the treadmill exercise. The percent of oxygen extracted from the inspired air breathed (a measure of lung ventilation efficiency) was not significantly different in the two exercise groups.

TABLE III.
COMPARISON OF STEP-UP AND TREADMILL EXERCISE IN 37 DIATOMITE WORKERS

		Step-Up Exercise	Treadmill Exercise
Arterial Blood	Oxygen Saturation %	95.4	96.1
	CO_2 Content Vol. %	43.6	43.2
	pH	7.44	7.45
Pulse Rate per minute		110	107
Respiration per minute		23	20
Ventilation L/min/sq.M./BSA.		11.69	11.92
Tidal Air ml.		970	1152
CO_2 Output, ml/min/sq.M./BSA.		385	433
Oxygen Uptake ml/min/sq.M./BSA.		506	549
Oxygen % Extracted from Inspired Air		4.65	4.73

The individual pulmonary function data are presented in Table IV for the 20 diatomite workers out of the group of 98 that were classified as having either a moderate or severe degree of pulmonary function impairment. The maximal breathing capacity was significantly decreased in 12 of the men, and exhalation time was significantly prolonged. The increase in the absolute volume of the residual air was a significant factor in the disability evaluation in 14 of the subjects. The ratio of residual to total lung capacity was increased in a slight to moderate degree only in nine cases (residual percent of total lung capacity 35% to 50%). Intrapulmonary mixing was moderately to severely impaired in seven cases (alveolar N_2 percent greater than 3% after seven minutes of oxygen breathing) (Table IV). The arterial blood oxygen saturation was decreased in all 20 cases in the supine position on air breathing, a moderate decrease (91.9% to 94%) in 10 cases, a slight decrease (94% to 96%) in nine cases and a marked decrease (saturation less than 92%) in one case. In 16 of the above cases the saturation was 96% or more with the IPPB on compressed air only. In eight out of the nine cases tested with a graded level of high oxygen breathing (32% oxygen, increasing the inspired pO_2 by over 70 mm Hg) the saturation was still significantly decreased with step-up exercise, being less than the normal value of 97% or more (Table IV). On 100% oxygen breathing the saturation was significantly decreased in only one case at rest (95.8%). The exercise oxygen uptake was markedly decreased in nine, moderately decreased in seven and normal in the other four. The decrease in exercise oxygen uptake indicates the inability to increase the pulmonary blood flow in accordance with the degree of exercise given, and indirectly indicates increased pulmonary vascular resistance.

A correlation was made of the over-all degree of pulmonary function impairment for the 98 diatomite workers based on the battery of tests

TABLE IV.

PULMONARY FUNCTION MEASUREMENTS IN 20 DIATOMITE WORKERS WITH A MODERATE OR

	1	2*	3*	4	5	6*	7	8	9	10	11*	12
X-Ray Classification	N_2C_1	N_2C_2	N_3C_2	N_1	O	N_2C_2	O	O	O	N_2C_2	N_2C_2	O
Vital Capacity, % Predicted	97	131	82	103	91	88	88	108	81	87	107	139
3 Sec. Timed Vital Capacity % Predicted	97	85	65	97	93	83	67	91	86	69	83	117
Maximal Breathing Capacity % Predicted Before	97	56	69	90	104	62	75	95	82	45	81	106
After Bronchodilator	104	77	75	114	104	67	86	95	91	62	85	121
Residual Air % Predicted	201	127	120	118	150	104	173	108	242	131	196	219
Residual Air, % Total Lung Capacity	40.8	29.3	32.8	27.7	29.3	28.3	39.9	25.0	49.9	33.2	37.9	34.5
Ventilation Factor % Predicted	85	81	70	93	88	67	68	95	76	63	77	98
Alveolar N_2 After 7 minutes of O_2 Breathing	4.3	2.8	2.0	0.6	0.7	3.8	3.2	2.7	1.8	4.0	4.6	1.2
Arterial Blood Oxygen Saturation % Rest, Air	92.3	92.3	94.2	93.3	94.4	92.1	91.9	95.9	94.3	94.8	92.7	95.8
Rest, IPPB, Air	97.4	96.0	96.6	—	96.7	96.0	95.0	97.3	97.9	97.7	98.0	99.0
Rest, 100% O_2	100	98.6	98.3	98.4	98.8	98.2	97.8	98.8	100	100	99.2	100
Exercise, Air	92.4	91.8	89.3	91.5	92.0	93.0	93.4	95.0	95.4	94.5	91.5	97.7
Exercise, 32% O_2	—	95.5	93.0	94.9	94.8	95.5	—	—	—	—	—	—
CO_2 Content Vol.%. Rest	41.8	46.1	46.2	47.7	51.6	42.0	48.3	49.5	47.2	46.8	46.0	48.6
Exercise	41.2	43.7	44.9	48.0	50.1	41.5	46.9	48.5	41.6	43.7	46.0	47.6
pH Rest	7.40	7.45	7.44	7.44	7.40	7.46	7.48	7.49	7.45	7.48	7.45	7.54
Exercise	7.39	7.46	7.41	7.42	7.40	7.46	7.49	7.48	7.39	7.42	7.45	7.45
Exercise Ventilation L./Min/ Sq.M./B.S.A.	9.95	10.4	10.4	6.56	9.13	8.83	12.4	7.13	20.7	11.0	8.16	9.16
Exercise Oxygen Uptake ml/min/sq.M./B.S.A.	387	381	427	388	412	358	437	389	400	447	367	442

O-Negative X-Ray. N-Nodular 1, 2 or 3. C-Conglomerate 1, 2 or 3.
*Severe Degree of Function Impairment.

measurements (as given in Table II) and the roentgenological classification (Table V). The degree of pulmonary function impairment was classified as normal, slight, moderate, or severe, based on all the tests described. In the group of 98 workers, 30 were classified as normal, 48 with a slight degree, 14 with a moderate degree, and only six with a severe degree of pulmonary function impairment (Table V). In the group with normal function, 16 had negative x-rays, nine had linear-nodular changes and five had nodular-confluent changes. In the group with a slight degree of function impairment the x-ray changes were classified as 20 negative, 18 linear-nodular and 10 nodular-confluent. In the group with a moderate degree of function impairment five were negative, five linear-nodular and four nodular-confluent. In the six cases with a severe degree of function impairment one had linear-nodular changes and five nodular-confluent. The individual diatomite workers with nodular-confluent x-ray changes appear more likely to have abnormal function measurements than the negative x-ray group. However, in the individual case, good pulmonary function measurements may be present with extensive nodular-conglomerate x-ray changes. Thus, on an over-all basis, there was a lack of correlation of the degree of pulmonary function impairment and the roentgenological finding in the group of diatomite workers. Similar findings have already been reported for both hard and soft coal miners' pneumoconiosis.[12]

TABLE V.

CORRELATION OF THE DEGREE OF PULMONARY FUNCTION IMPAIRMENT AND ROENTGENOLOGICAL CLASSIFICATION IN 98 DIATOMITE WORKERS

	DEGREE OF PULMONARY FUNCTION IMPAIRMENT**				
Roentgenological Stage*	Normal	Slight	Moderate	Severe	Total
Negative	16	20	5	0	
Total All Cases Negative					41
Linear-Nodular					
First Stage	7	12	5	0	
Second Stage	1	2	0	0	
Third Stage	1	4	0	1	
Total Linear-Nodular Cases	9	18	5	1	33
Nodular-Confluent					
Nodular Second, Confluent First	3	2	1	0	
Nodular Third, Confluent First	0	2	0	0	
Nodular Second, Confluent Second	2	3	1	3	
Nodular Third, Confluent Second	0	3	2	2	
Total Nodular-Confluent Cases	5	10	4	5	24
Total, All Cases	30	48	14	6	98

*X-ray classification of U.S. Public Health Service.
**Over-all evaluation based on complete battery of tests as described. *Dis. Chest.*, 24:378, Oct., 1953.

Discussion

The pulmonary function studies indicate that early changes in diatomaceous earth pneumoconiosis are commonly reflected by a decreased timed vital capacity for three seconds and the MBC or an increase in the residual air or both. The MBC was decreased more than the timed vital capacity for three seconds in the diatomite workers. In the survey group only a few subjects had a significant degree of pulmonary emphysema, on a basis of the ratio of residual

SEVERE DEGREE OF IMPAIRMENT

13	14	15	16*	17	18	19*	20
N_3C_2	N_1	N_1	N_2	N_1	N_3C_2	N_3C_2	N_1
100	97	121	100	80	84	112	109
72	79	110	83	78	79	90	102
64	65	54	96	111	81	71	105
75	81	89	100	111	84	86	104
190	158	186	133	84	171	138	182
38.8	35.2	33.9	36.2	26.0	40.5	34.6	35.8
67	72	79	87	95	74	82	92
2.2	4.1	1.2	1.7	1.2	2.5	4.3	1.1
93.8	94.4	94.5	92.5	88.9	93.6	94.4	92.2
99.0	—	96.8	93.5	98.1	98.5	97.6	96.4
—	—	99.8	95.8	100	—	—	100
96.9	98.0	95.2	84.8	93.5	91.6	89.5	92.5
—	—	—	90.5	95.2	—	97.6	96.3
43.3	45.2	41.9	45.1	46.6	50.1	49.4	47.6
41.8	40.8	40.3	43.3	43.5	44.9	50.4	46.6
7.44	7.49	7.52	7.53	7.42	7.43	7.44	7.50
7.47	7.51	7.45	7.43	7.39	7.41	7.44	7.43
7.86	15.6	8.03	17.5	9.93	7.84	7.04	11.0
383	533	316	615	523	434	221	496

to total lung capacity, even where the absolute volume of the residual air was significantly increased, since the total vital capacity was good. When the residual air volume is markedly increased (above 160% of predicted normal) a potential hazard exists, and such a subject should be carefully followed. The MBC was decreased below 60% of predicted in one case and there were only five between 60% and 70%. The MBC has a wide spread between the normal and most abnormal, and represents a valuable sensitive test to detect early lung function changes. The average MBC in the survey group was increased 12 liters per minute after one bronchodilator treatment with isproterenol (Isuprel). Bronchospasm of a mild to moderate degree was of frequent occurrence. The MBC may be reduced very significantly to 75 liters per minute or less and still be high enough in general to denote freedom from dyspnea except with most strenuous exertion, because of the large breathing reserve in the lung.

A slight to moderate decrease in the arterial blood oxygen saturation in diatomite pneumoconiosis was of frequent occurrence, although not usually severe enough to be disabling, as the saturation was above 90% in all except four at rest, and in all of these the exercise saturation was increased above 90%. In three subjects the saturation was decreased below 90% with exercise. Direct tension measurements of the arterial blood at rest in the survey group did not lend any evidence to a diffusion difficulty, as judged by the alveolar-arterial pO_2 difference, even when the saturation was decreased markedly (average A-A difference 13.5 mm Hg, range 1-32). Diagnostic studies with intermittent positive pressure breathing with compressed air only at rest and with a graded level of high oxygen breathing (32% oxygen) during step-up exercise indicate that the factors responsible for the lowering of the arterial blood oxygen saturation are poorly ventilated alveoli and shunting of blood through nonventilated areas, especially during exercise. No evidence of an alveolar-capillary membrane block has been found in diatomite pneumoconiosis. The arterial CO_2 content and pH both during rest and during exercise were not significantly altered.

The pulmonary ventilation measurements reveal wide individual variations, with a marked decrease in the exercise oxygen uptake in some of the cases. The percentage of oxygen extracted from the inspired air breathed was quite variable and was not of much help in evaluating the degree of pulmonary insufficiency. The marked decrease in the exercise oxygen uptake in the presence of an adequate minute ventilation in a few cases indicates increased pulmonary vascular resistance, and an inability to expand the pulmonary vascular bed in a normal manner so as to increase pulmonary blood flow.

These studies indicate that evaluation of the pulmonary function impairment and especially early changes cannot be made from the x-ray. In general the x-ray deviations from normal are much more marked than the pulmonary function changes. The rapidity with which further changes may develop in those cases with abnormal findings, if they do, is unknown. If the residual air volume in a given case is increased 40% to 60% above the normal predicted and the total vital capacity is still good, and serial follow-up studies after two or three years have revealed no further progression, such a worker could be allowed to continue on his job with good assurance.

On the other hand, if serial measurements revealed progressive increases in the residual air measurement, then there could be no doubt that this individual should be removed completely from all exposure to the dust, a benefit to the individual and to the industry. To evaluate more adequately the significance of the early changes noted in pulmonary function requires serial follow-up studies. The pulmonary function studies in diatomite workers has been found similar to that found in coal miners' pneumoconiosis and silicosis in general.[12]

Summary

1. The nature and extent of the changes in pulmonary function was determined in 98 diatomite workers (selected to represent a cross section of the industry) by a complete battery of

tests, and the over-all evaluation of the impairment revealed a severe degree in six, a moderate degree in 14, a slight degree in 48, and no significant change in 30.

2. The early pulmonary function changes consist of slight to moderate decrease in the maximal breathing capacity and the timed vital capacity for three seconds and/or an increase in the residual air. A slight to moderate decrease in the arterial blood oxygen saturation was observed from the perfusion of blood in pulmonary capillaries supplying poorly ventilated alveoli and/or nonventilated areas of the lung (ventilation-perfusion abnormalities). Impairment in the normal expansibility of the pulmonary vascular bed was observed.

3. No apparent correlation has been found in the present study between the pulmonary function measurements and the chest roentgenologic appearance. The evidence from the present study indicates that disability evaluation cannot accurately be made from the x-ray appearance, and, furthermore, removal of a worker from the job should not be made on a basis of the x-ray. Although the six cases in this study with a severe degree of function impairment had extensive x-ray changes, other workers with similar changes had normal function.

4. Serial follow-up pulmonary function studies are needed better to evaluate the significance of early changes in relation to progression and to prevent the development of severe disability, such as has occurred in diatomite workers.

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Cholesterol and Television Athletes

The urban American male is as different in his living habits from his counterpart of a generation ago as he is from the Bantu native of South Africa, said a leading pathologist, Dr. David M. Spain of Beth-El Hospital, Brooklyn, in discussing possible causes of coronary artery disease at a conference — sponsored by the New York Academy of Sciences and the Research Institute for the Study of Man which was held in New York City June 2.

The physician said the softer life and richer diet of today's American are the leading contenders for the chief causative role in heart disease, the nation's leading killer. Correlation between higher levels of cholesterol in the blood and coronary heart disease is striking, especially in men under 50. (The Bantu has a low blood cholesterol and, in contrast to Americans, a low incidence of atherosclerosis. He also has a low standard of living, which he is doing his best to raise.)

The Brooklyn pathologist, who has had several thousand Jewish persons from this area under study for three years, said that with a blood cholesterol level over 300 milligrams per 100 cubic centimeters of serum, a man has three times the chance of suffering a heart attack as a man with a level of 200 or less.

Dr. Spain notes that his best statistical efforts have not been able to incriminate smoking or hypertension as reasons for the recent marked increase in the incidence of atherosclerosis. He characterized the changes in our lives over the past 30 years as follows: "There has been a many-fold increase in automotive transport, undreamed of advances in mechanization and automation in industry, average diets with a high percentage of animal fats, a relatively prosperous society as compared with the depression period.

"With the advent of television, a new industry has developed which prepackages frozen ice cream, whipped cream desserts and delicacies designed to tempt the viewer. While the viewer is in this oblivious state he munches continuously.

"His only exercise night after night is to take five or ten vigorous steps from the chair by the television to the door of the refrigerator. In short we have become a nation of television athletes."

Overlooked and Misdiagnosed Fractures

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For one reason or another fractures are occasionally overlooked and misdiagnosed. In order to promote the patient's earliest possible recovery from trauma, in order to avoid future reconstructive orthopedic surgical procedures, in order to prevent prolonged morbidity and crippling complications—in short, in order to render the best service to our patients—it behooves us to make accurate diagnoses of skeletel injuries. Patients are justifiably dissatisfied and disgruntled when their overlooked injuries lead to unnecessarily prolonged suffering and loss of income or result in added expense at a later date.

The following is a series of overlooked or misdiagnosed skeletal injuries which have ultimately come to the attention of the author.

Case No. 1—is that of an elderly female who fell at home and injured her left hip. An x-ray examination was made in her community hospital immediately after her accident. It was interpreted as being negative. She was encouraged by her physician to walk in a walker and bear weight. The hip became progressively worse. Five weeks later, on examination by the author, x-rays showed a fracture of the neck of the femur with angulation and displacement (Figure 1). Fibrous union prevented reduction. The head of the femur was, therefore, replaced by an endoprosthesis.

Associated Fracture Found

Case No. 2—is that of a middle-aged man who was involved in an auto accident. There was an obvious fracture of the shaft of the femur clinically. X-ray examination by portable unit showed the fracture and portions of the shaft proximal and distal to the break (Figure 2). The fracture was treated by open reduction and Hansen-Street nail fixation. Two months later progress with regard to the femoral shaft fracture was excellent, but he was then complaining of discomfort

Figure 1
Anteroposterior view of left hip at five weeks. Earlier films considered negative for fracture.

From *The Journal of the Indiana State Medical Association*, March, 1960.

Figure 2
Middle third of femur fracture. Film unsatisfactory because it does not depict the head and neck of the bone.

Figure 3
Same case as Figure 2 two months after injury. Intramedullary nail in place. Associated fracture of femoral neck just discovered.

Figure 4
Acute elbow fracture in child. Displaced lateral epicondyle fracture evident.

Figure 5
Same fracture as Figure 4, neglected, after 18 months; resulting in deformity and dysfunction.

in the region of the same hip. X-ray examination revealed an associated fracture of the neck of the femur, hitherto undiagnosed (Figure 3). This fracture fortunately was amenable to manipulation and Moore pin fixation with a satisfactory result.

Case No. 3—is one of a child's elbow fracture which was overlooked in spite of a good early x-ray film (Figure 4). The elbow was treated like a sprain with a sling and a bandage. The elbow became comfortable but nonunion with resultant deformity and dysfunction developed (Figure 5). The lateral epicondyle and capitellum were fractured off and displaced. Such a fracture must be perfectly reduced and adequately fixed, preferably with two Kirschner wires driven across the fragments for a satisfactory result. A good policy is to obtain films of the other elbow for comparison.

Case No. 4—is that a mature white male who fell off a truck landing onto his right hand, injuring the wrist. He was treated by "shots" and bandages for two weeks. When the swelling had subsided a short arm cast was applied and kept in place for eight weeks. He denied he had been given an anesthetic or that his wrist was manipulated. When first seen by the author, eight months after his injury, he was unable to use his right wrist and hand. X-rays revealed a carpal navicular fracture and a perilunar dislocation, with avascular necrosis of the lunate bone (Figure 6).

Second Element Found Later

Case No. 5—is that of a child's forearm injury. The original diagnosis was greenstick fracture of the shaft of the ulna. It was treated by plaster cast immobilization for one month. It was not until the cast was removed that a dislocation of the radial head was discovered. The original and up-to-date x-ray films submitted by the treating doctor revealed a Monteggia's fracture (Figure 7). Both elements of this injury should have been treated initially by manipulative reduction,

Figure 6
Right wrist eight months post-trauma. Neglected fracture of carpal navicular and perilunar dislocation. Note avascular necrosis of lunate bone.

Figure 7
Neglected Monteggia fracture after four weeks of cast immobilization. Neither fracture nor dislocation were reduced.

flexion at the elbow and supination of the forearm. Ultimately the ulna remodeled. The ruptured annular ligament was reconstructed with a fascia lata graft.

Case No. 6—is that of a hyperextension neck injury. The original x-ray (Figure 8) examination was reported "No evidence of fracture or dislocation." Because of the severe persistent symptoms the films were reviewed. A fracture of the neural arch of the second cervical vertebra with anterior spondylolisthesis of the body on the third cervical vertebra was discovered. An overlooked fracture at this level is potentially dangerous to life.

Case No. 7—is that of a middle-aged farmer who fell climbing over a fence, injuring his right shoulder. On the basis of the x-ray report, "the films are of inadequate detail, but there is no

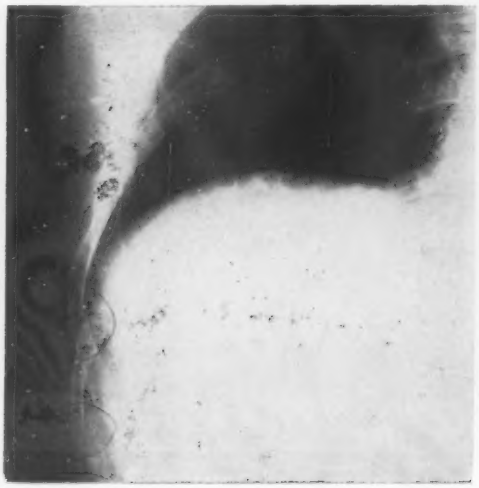

Figure 10
Fractured ribs diagnosed as "pleurisy."

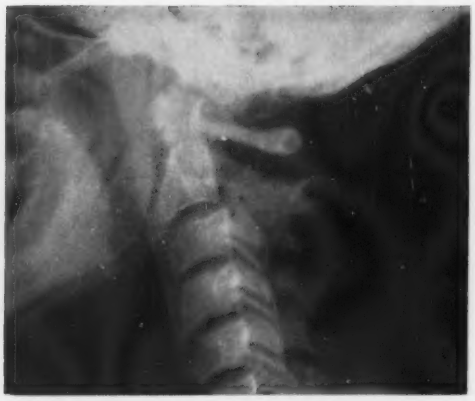

Figure 8
Fracture of neural arch of C-2 with anterior displacement of body on C-3.

Figure 9
Fracture dislocation of right shoulder misdiagnosed because of poor quality of film.

Figure 11
Checkup x-ray examination of treated fracture of right clavicle reveals unsuspected greenstick fracture of other clavicle as well.

Figure 12
Fatigue fracture of tibia thought possibly to be early bone tumor.

evidence of fracture or dislocation of the scapulo-humeral joint" (Figure 9), the patient was treated for one month with a sling. When his shoulder did not improve his physician referred him for specialist care. Films of better diagnostic quality were then obtained, revealing a dislocated shoulder with displaced fracture of the greater tuberosity of the humerus. An open reduction and shoulder reconstruction had to be performed.

'Pleurisy' Is Rib Fracture

Case No. 8—is that of a middle-aged female who had cough and pain in the chest. She was treated at home for two weeks for pleurisy. On admission to the hospital a careful history uncovered the fact that she had fallen against her porch just before the pain appeared. An x-ray film (Figure 10) was then obtained showing two ribs to be fractured.

Case No. 9—is that of a 5-year-old boy who was struck by a car and sustained multiple injuries. There was an obvious fracture of the right clavicle. This was confirmed by x-ray. At a later date when a checkup x-ray examination was made (Figure 11), including the other clavi-

Figure 13
March fracture treated for months as "foot strain" or "metatarsalgia."

cle on the same film, an unsuspected fracture of the left clavicle was an incidental finding.

Case No. 10—is that of a 14-year-old boy who complained of pain in the proximal third of the left leg. There was no history of injury. X-ray films revealed periosteal bone reaction on the posterior surface of the tibia (Figure 12). A bone tumor was suspected. Prolonged observation proved the condition to be a fatigue fracture.

Case No. 11—is that of a middle-aged female who had pain in her left foot for months. Chiropodists and physicians treated her with arch supports and shoe modifications. She obtained no relief. Ultimately an x-ray examination was made (Figure 13). A March fracture of the second metatarsal bone was found.

Case No. 12—is that of a mature female who slipped on a rug and injured her left ankle. She was given definitive treatment by her family physician. Some time later she was admitted to a charity hospital and placed on the orthopedic service. X-ray films through her cast on admission showed fractures of the medial malleolus and the shaft of the fibula in good alignment, but there was gross diastasis of the ankle mortise (Figure 14). Open reduction and Webb bolt fixation were performed.

Summary

Each of the cases cited teaches a lesson. It seems trite to emphasize the virtues of a careful history and physical examination. The value of adequate x-ray film in quality, in quantity and in unlimited extent is poignantly obvious. Where there is a history of a fracture-producing accident, but where there is no evidence of fracture on initial x-ray films, re-examination by x-ray in 10 to 14 days may pay dividends. In the intervening time resorption of bone or displacement may occur, disclosing a fracture.

Figure 14
Both bone fracture right ankle. Given definitive treatment by cast. Diastasis of ankle mortise overlooked.

Closer collaboration between the treating physician and the radiologist is recommended. Blind treatment of a severe injury from an x-ray report is hazardous. Too often the radiologist is at a disadvantage, having only a film on which to base a diagnosis; if he knew the clinical picture he would be guided to the injury and issue a more reliable report.

Finally, if we accept patients with complicated and serious injuries, we must train ourselves to interpret x-ray films, be conversant with the pitfalls inherent in each fracture problem, and always be aware of the possibility of anomalies, fatigue fractures, associated fractures and joint injuries.

IHF Reports

The Industrial Hygiene Foundation of America, Inc., a nonprofit research association of industries for advancing hygiene and occupational health, has prepared a booklet describing its services, including the collection and dissemination of information; environmental studies, and toxicological, biochemical and histopathological research. Copies of this booklet may be obtained free of charge from the Industrial Hygiene Foundation, 4400 Fifth Avenue, Pittsburgh 13, Pennsylvania.

The Diagnosis of ABDOMINAL PAIN

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It is rare in the practice of industrial medicine that a physician treats a patient with abdominal pain. A few generalizations in diagnosis, however, may be pertinent in simplifying the approach to this problem of the doctor in industry, so that he may be better prepared and more aware when the condition presents itself.

Inspection of the normally scaphoid abdomen will quickly determine the presence of diffuse peritonitis or perforated viscus, for example, where the abdomen is held in a rigid fixed position. Distention or visible masses, as well as enlargement of intra-abdominal organs, are also notable.

Gentle palpation for elicitation of pain, tenderness, rigidity or spasm, percussion for evaluation of increased air or fluid, and auscultation of diminished, absent or increased bowel sounds are methods with which we are all familiar and are mentioned merely for emphasis. Rectal examinations should never be omitted.

Location and Type of Pain

In the final analysis, many factors must be considered in making a diagnosis; the consistence and persistence of symptoms, the presence of tenderness with rebound, character of the bowel sounds, appearance of the patient, and the manner in which these manifestations change over a period of a few hours.

Diseases requiring early surgical intervention are acute appendicitis, acute cholecystitis, acute intestinal obstruction, incarcerated and/or strangulated hernia, ectopic pregnancy, perforating lesions of the gastrointestinal tract, mesenteric vascular occlusion, splenic rupture, torsion of pedicle of intra-abdominal tumor, ruptured gallbladder, rupture of an intra-abdominal abscess, and spontaneous intra-abdominal hemorrhage.

Appendicitis

In considering the causes of abdominal pain, the diagnosis of appendicitis would be correct in many cases on the basis of probability alone. The pain of appendicitis is one of the few beginning without prodromata, is continuous and severe, occasionally colicky (in 10% of cases) sometimes with intermittent exacerbations, between which there is a constant dull ache aggravated by moving or walking. It is initially in the epigastrium or periumbilical area radiating later to the right lower quadrant.

Anorexia is usually present, and vomiting is often absent. When present, however, vomiting follows the pain and the ingestion of water or food. Constipation is common, diarrhea and chills are not.

Tenderness is second only to pain as a constant and dependable feature of acute appendicitis, localizing itself to a small area in the right lower abdomen. Rebound is often present, but this is subjective evidence and must be carefully evaluated, especially in children and older patients. Rectal examination may reveal an abscess on many occasions.

Cholecystitis

The most prominent symptom is pain, gradual in onset if due to an inflammatory process, or sudden if a stone is impacted in the cystic or common duct. Pain begins three to four hours after a meal, usually in the epigastrium later shifting to the right upper quadrant. It is severe and constant, increasing slowly to a peak of severity, and recurring as soon as the effect of

analgesics disappears. In approximately 50% of patients there is radiation to the interscapular or right infrascapular region.

Vomiting is variable, intense nausea is usual. Tenderness localizes to the right upper abdomen unless the gallbladder becomes distended, forming a palpable mass in 36 to 48 hours.

Intestinal Obstruction

Early incomplete small bowel obstruction can exist with very slight distention since the proximal bowel is being decompressed by vomiting. Vomiting is severe and almost continuous with high obstructions. It should be emphasized that in the diagnosis of acute abdominal pain all measurable degrees of distention, however slight, are significant.

The increase of peristaltic sounds is extremely important in the diagnosis of intestinal obstruction. Sounds may be increased in the early stages, but will disappear later, especially if peritonitis develops. When present, they are typically high-pitched.

Frequently little or no gas-distended bowel may be seen on a supine x-ray film, but with the patient upright, fluid levels are noted — an unmistakable indication of stasis.

Absence of bowel movements is not an early symptom of obstruction. There may be diarrhea in a partial block, and even after a complete block, contents distal to the lesion must evacuate.

Obstructive pain is cramping, coming in waves of rhythmic periodicity and free intervals between paroxysms. At the peak of each pain an obstructive (high-pitched tinkle) bowel sound may be heard.

Hernia

Incarcerated hernias are irreducible, and if they contain bowel, produce all symptoms of intestinal obstruction. Later, if impairment of blood supply to incarcerated viscera occurs, strangulation ensues. Richter's hernia, where only a portion of the bowel wall is caught, may produce symptoms of strangulation without initial evidence of obstruction. Strangulation is also common in femoral hernias (which can be frequently overlooked in an obese person), and should be suspected if the pain is constant, severe, and the overlying skin is red, inflamed and edematous. The diagnosis of strangulation can be made with certainty only at surgery, hence all incarcerations should be treated by surgery immediately.

Ectopic Pregnancy

This possibility exists in all women of childbearing age who have lower abdominal pain.

Perforating Lesions of Colon

Slowly perforating cancer or diverticulum of the sigmoid produces left lower abdominal pain and tenderness. Differentiation between these two is often difficult even at surgery, and we must look to the pathologist for help. The patient with diverticulitis has a longer history of con-

TABLE I.
DIFFERENTIAL DIAGNOSIS OF LOWER ABDOMINAL PAIN

	Acute Appendicitis	Ureteral Obstruction	Acute Salpingitis	Ectopic Pregnancy	Diverticulitis
Age	Usually under 40	Under 40	Under 40	Under 40	Over 40
Sex	Both	Both	Female	Female	Male
Pain	Epigastric, shifts to R.I.Q., constant with exacerbations	Severe, knifelike, begins in lumbar area, radiates to groin, scrotum, thigh; dysuria, frequency	Dull, constant, both L.Q.; recurrent attacks; jarring painful; backache; dysuria	Sharp, knifelike	Dull-cramping; L.L.Q. pain; diarrhea+
Menses	——	——	No change or menorrhagia	Missed or scanty period; 15-25% have no irregularity	——
Temperature	99-103 F. before perforation	Normal	99-102 F.	Normal	99-101 F.
Tenderness	Localized R.L.Q. Rebound	Costovertebral; none in abdomen	Bilateral L.Q.; suprapubic; rebound	Unilateral L.Q.; rebound	L.L.Q.; rebound; mass+; mild distention+
Pelvic exam.	Tenderness high on right	——	Exquisite tenderness on movement of cervix; profuse purulent discharge	Cervix moderately tender to movement; bloody discharge (dirty brown)	——
Laboratory	Hematuria 6% normal sed. rate; leukocytosis	Hematuria; no leukocytosis	Skene and Bartholin positive for gonococcus; sed. rate elevated	Aschheim-Zondek may or may not be positive; cul-de-sac puncture — blood	Leukocytosis
X-ray	No help	See stone on flat plate 85%; I.V. pyelogram helps	No help	No help	No help unless barium x-ray previously showed diverticulosis

It should be emphasized that the data in this table represe nt usual findings and are not to be construed dogmatically.

stipation and bowel disturbance, showing no weight loss, as contrasted with carcimoma, where there is a story of recent bowel disturbance, weight loss, and anemia. Bleeding is common to both, but more typical of neoplasm. Similar lesions in the cecum produce symptoms identical to appendicitis.

Mesenteric Vascular Occlusion

Abdominal pain may be present for days or weeks, producing nausea, vomiting, and diarrhea, just prior to the final acute episode. When part of the bowel becomes devitalized, pain becomes intense, changing from intermittent colicky to a continuous agonizing type. Diarrhea and constipation are common, the latter due to the ileus. Shock is a late and very serious sign.

The lack of abdominal rigidity in the presence of exquisite diffuse abdominal tenderness is a striking finding. Peristalsis ceases and distention occurs quickly in most cases, but the latter is not as extreme as in mechanical obstruction. There is no tympany, because of the fluid and blood in the intestine. X-rays lack diagnostic features.

Diagnosis is based on the following:

1. Previous attacks of phlebitis or existing cardiac irregularity (fibrillation, etc.)
2. Abdominal discomfort with constipation or diarrhea
3. Severe abdominal pain out of proportion to physical findings and difficult to relieve with opiates
4. Tenderness without rigidity
5. Slight temperature rise
6. Blood on rectal exams

Perforation of an intra-abdominal viscus is marked by sudden onset of intense, diffuse abdominal pain, tenderness, rebound, absent peristalsis and prostration. Peptic ulcer, ruptured gallbladder, intra-abdominal abscess, splenic rupture (spontaneous or traumatic) and spontaneous intra-abdominal hemorrhage enter this category.

It is extremely important for one to approach surgery cautiously in abdominal pain associated with acute respiratory infections, acute enteritis, rheumatic fever, malaria, sickle-cell anemia, lead poisoning, porphyria, periarteritis, diabetes mellitus, acute pancreatitis, urinary tract disease or coronary occlusion. In all of these there is accompanying abdominal symptomatology which may merely be secondary to the underlying disease. As a corollary to this, however, I personally have seen cases of acute appendicitis and measles occurring concurrently; therefore, it is important to keep in mind the possibility of surgery in spite of, or, in association with, the so-called "medical entities."

Mention should be made of regional ileitis and

TABLE II.
DIFFERENTIAL DIAGNOSIS OF UPPER ABDOMINAL PAIN

	ACUTE APPENDICITIS	ACUTE CHOLECYSTITIS	PERFORATED PEPTIC ULCER	ACUTE PANCREATITIS	PLEURISY AND PNEUMONIA	CORONARY OCCLUSION
Age	Usually under 40	Over 40	30-50	30-50	Any age	Over 40
Sex	Both	Female, fat	Rare in females	Females predominate	Both	Male
Pain	Epigastric, shifts to R.L.Q.; constant, with exacerbations	Severe, radiates to back and shoulder; requires morphine; relieved by antispasmodic	History of ulcer in 60-75%; sudden onset, intense, constant pain, requires morphine	Sudden onset after large meal; severe, constant; radiates to back; requires morphine	In upper abdomen, not localized; relieved by splinting respiratory muscles	Lancinating; radiates to left shoulder and arm
Vomiting	Exception, but always anorexia	Reflex, may be much retching	Not prominent	Always	Exception	Reflex
Appearance	Not acutely ill until peritonitis	Worn because of pain	Acutely ill; keeps abdomen immobile; shocklike	Acutely ill; shocklike if necrosis	Restless; may have grunting respirations	Dyspneic, cyanotic, very restless, sweating; B.P. subnormal
Temperature	99-100 F.; higher after perforation	99-102 F.	Subnormal	Subnormal at onset, later variable	100-103 F.	Normal to subnormal
Tenderness	Localized R.L.Q.; rebound	Localized R.U.Q.	Diffuse, more in upper abdomen; board-like rigidity; absent bowel sounds	Epigastric; rebound; bowel sounds decreased	Epigastric, inconsistent; no rebound; no restriction of abdominal respiratory movement	Upper abdomen but changeable and inconsistent
Laboratory	Leukocytosis usual	Leukocytosis	Leukocytosis	Serum amylase elevated; glycosuria occasional	High leukocytosis	Leukocytosis; E.C.G. very helpful
X-ray	No help	May show stones or non-visualization of gallbladder	Free air in 85% 4 hrs. after onset	"Sentinel loop" of small bowel	Chest x-ray diagnostic	No help

It should be emphasized that the data in this table represent usual findings and are not to be construed dogmatically.

Meckel's diverticulum. The former is a chronic granulomatous disease involving the terminal ileum and "skip" areas proximal to the main lesion. Intestinal colic, slight distention, borborygmi and occasionally a right lower quadrant mass are noted. Young people are affected, and, because of chronic diarrhea and melena, nutrition is poor. Chronic partial obstruction is common.

The clinical symptoms of Meckel's diverticulum are more often those of small bowel obstruction than inflammation, usually caused by kinking of the intestine over a band between the tip of the diverticulum and the abdominal wall. The pain varies in character and location, the preoperative diagnosis most often being appendicitis.

Hemorrhage is common in children under two years, but recurrent attacks of abdominal pain and melena suggest a Meckel's. The bleeding may frequently be bright red and massive enough to lower the blood count, a fact distinguishing this entity from intussusception.

In conclusion, let me re-emphasize the importance of a careful history, adequate physical examination and a deliberate evaluation of all the salient features from both. This is, indeed, the most reliable method of reaching a reasonable conclusion in the clinical differential diagnosis of abdominal pain.

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One Monk's Meat

Trappist monks, who eat no meat, have less cholesterol in their blood than Benedictine monks, who do eat meat, according to a group of scientists who are conducting a study of cholesterol with the support of the National Heart Institute.

The report is made by a group of five researchers from the Georgia Department of Public Health who have been studying the blood-cholesterol levels of members of two monastic orders. The long-range goal of the study is to discover whether one of the two groups develops atherosclerosis at a faster rate than the other or suffers more from attacks of coronary disease.

On the average, Trappists derive 26% of their calories from fat, Benedictines 45% (about the U. S. average). Animal fats such as those in eggs, cream, butter, account for only 43% of the fat in the Trappist diet; the same foods, plus meats, account for 75% of fats in the Benedictine diet.

The other major dietary difference between the two groups of monks is in the percentage of total calories obtained from carbohydrates — starchy and sweet foods. This is 64% for the Trappists and 42% for the Benedictines. Proteins made up 10% of the Trappist diet and 13% of the Benedictine.

The stability of monastic life, and the similarities between the two communities, the researchers suggest, make the two communities suitable subjects for comparison in such a long-term study, but they also point out differences: the Trappists are withdrawn from the world, devoted to contemplation, prayer, and physical labor. They neither drink nor smoke. The Benedictines are teachers and preachers, involved with the world; neither drinking nor smoking is prohibited for them.

Results in the first year, in which blood was analyzed four times, bear out the contention of cardiologists who maintain that diets high in animal fat cause blood-cholesterol levels to rise. Dividing the men into five age groups by decades, the scientists found: For Trappists in the twenties, blood-cholesterol averaged 184 milligrams per hundred cubic centimeters of serum; for those in the thirties, 195; in the forties, 210; in the fifties, 220; in the sixties, 212. For Benedictines the comparable figures were 223, 240, 239, 258, and 229.

The serum also was analyzed for other fat-like substances and, in each case, the values were comparably higher for Benedictines.

The study originally involved only 70 Benedictines and 80 Trappists. The success of the first year program has led to expansion to include 500 subjects in order to provide valid epidemiological data.

EXERCISE BOARD for INJURED HANDS

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The patient who has recovered from the acute phase of hand injury and is beginning the tedious process of restoring function is sometimes simply told to "exercise." A more definitive program of self-applied physiotherapy is instituted when he is instructed in detail regarding active and passive exercises with or without hydrotherapy. Squeezing a rubber ball most certainly is beneficial in many instances. In his textbook, *Surgery of the Hand*, Dr. Bunnell mentions the usefulness of a "a flat block of wood one-half inch thick with rounded edges" for exercise purposes.

The simple exercise board shown was designed to serve as an adjunct to the usual standard accepted physiotherapeutic measures employed to assist in the restoration of flexion. It was made from three-eighths inch plywood, and measures 12 inches in length. It is three inches wide at its broad end, and one inch wide at its narrow end. Material used and exact dimensions are unimportant, but the basic configuration of the board should be retained. This configuration extends the usefulness of the ordinary block of wood in that it permits its use in hands of virtually any size. In addition it is possible conveniently to exercise any or all joints of the fingers and thumb, and eliminates the occasional need for the use of two or three different sizes of rubber balls or wooden blocks. With the narrow end of the board the proximal joints may be exercised. The wide end serves to exercise the distal joints.

Such a tangible item as this held and used by the injured hand provides both physical and psychological therapy. The patient's attitude towards this suggested form of physiotherapy is generally good. The average patient is quite willing, if not anxious, to try.

A report on occupational health in Communist East Germany

Medical Care for Workers in the German Democratic Republic

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Systematic health protection measures evolved only with the expansion of modern industry. Many examples of the dreadful damage to health which workers had to endure at the beginning of this development frequently have been described in the literature.

After the cholera epidemic in England in 1831, more attention was paid to problems of public health in England and in Germany. In compliance with the demands of the working class, England had to pass a law on child protection in 1802, and was the first country to do so. This law, however, in no way covered all aspects of the problem and was followed by the prohibition, in 1814, of employment of children under nine years of age in cotton mills. At the same time, the upper limit for children under 16 years of age was fixed at 12 working hours. The labor safety legislation given to the English people was not passed until 1847.

In Prussia, too, children were engaged in occupations dangerous to health, devoid of any legal protection for a long time. Due to long working hours, they suffered from a lack of fresh air and healthy physical activity, and their extremely poor physical condition became more and more apparent. In the end, a youth protection act was passed in Prussia because the poor state of health in the youth was gradually beginning to endanger the future size of the army.

After 1881, the first social insurance system was founded in Germany. Despite its shortcomings in these days, the united social insurance legislation providing relief services for the poor among sick persons must be regarded as the most outstanding achievement in social welfare in Germany since 1870.

In the law on sickness insurance, passed in 1883, it had already been stated that workers were entitled to free medical treatment in case of sickness. As employers and employees alike contributed to the funds required for these services, the latter differed definitely from former benefits received on the basis of individual charity.

In 1891, the Reich Industrial Decree introduced German legislation on labor protection measures, and provided for the appointment of state trade inspectors. This decree is the actual foundation on which all other protective measures were built up. Among other problems, it contains stipulations on Sunday work, contracts of apprenticeship, working rules, child labor, women and youth labor, rights and duties of trade inspectors, health and special safety measures in factories.

In the trades decree of 1900, the employment of children under 13 years of age was prohibited. The daily working hours for children of 13 was not to exceed six hours; for young people between 14 and 16 the upper limit fixed at 10 hours. Night shifts were not allowed at all.

With the rise of imperialism in Germany, conditions for workers grew worse, as is shown by the rise in the rate of accidents at that time. At the moment when the frequency of accidents appeared about to endanger the smooth running of industrial production, an accident insurance system was considered for the first time and labor safety precautions were introduced on a larger scale.

West German statistics show that the rate of accidents is rising steeply there again.

In 1952, 23,608 fatal accidents were recorded; in 1953, this figure had risen to 26,765. In contrast, there were 6,000 fatal accidents in 1953 in the German Democratic Republic. The relation to the rate of fatal accidents is 2.5 times as

high in West Germany as in our republic.

The decree on working hours for workers, issued in December, 1918, introduced the 48-hour week in Germany.

During the Weimar era, the years between the world wars, medical specialists for professional diseases achieved good results in their work. These doctors must be regarded as the actual pioneers in setting up factory health services, improving general health and extending social security measures for the workers. Special attention was paid, in those days, to these groups whose work is dangerous to health. Numerous proposals were put forward for changing working conditions in all branches of industry. Some of the most prominent representatives of this medical branch were Teleky, Gerbis, Beyer and Holstein. Many a scientific treatise was published by these men, who also taught and lectured on these problems.

First-aid and life-saving services were hardly known in these days; the training received by first aid and medical personnel employed by factories was insufficient.

The social insurance system experienced a quick expansion during the Weimar era, although there existed as yet no united system; in fact, 7,210 different social insurances were known in Germany in 1924. Sickness, accidents, invalidity were dealt with by different companies. Two-thirds of the insurance fees had to be paid by the employee, one-third by the employer. In the 1920's, convalescent homes and sanatoria were set up by social insurance companies for the first time.

The hopeful beginnings were reduced to nothing during the Fascist era and nothing whatsoever was left of a factory health service. The number of persons whose wages were reduced grew steadily. At the same time increased mobilization and speed-up in production were enforced and an atmosphere of military drill created.

The importance of the factory health services in the German Democratic Republic lies in the fact that all working people can receive whatever medical treatment they require during working hours and on the spot.

In 1947, preconditions for a progressive and united factory health service were legally laid down in the German Democratic Republic. As a result, factory doctors in our part of Germany are free to represent unreservedly the interests of the working people. The following facilities are provided by the factory health service:

Factory outpatient clinics, for factories employing more than 4,000 workers, including at least four special departments, equipped with all necessary apparatus and equipment for diagnoses, therapeutic purposes, an x-ray department, a laboratory, a technical dental laboratory and a dispensary.

Factory health centers for factories with 2,000 to 4,000 workers, employing one or two doctors, according to the size of the works, and a dentist.

Factory first-aid departments for factories with 500 to 2,000 workers, employing one part-time doctor.

Factory first-aid departments run by nurses only, for enterprises with 200 to 500 employed.

Medical rooms for works with 50 to 200 employed. These medical rooms are voluntary aid centers run by helpers of the German Red Cross.

Overnight sanatoria, semi-inpatient establishments, are designed both to prevent and to cure sickness. The advantage of these lies in the fact that they not only make possible social rehabilitation of the sick, but that treatment provided there is intended to maintain the workers' ability to work. Cures in an overnight sanatoria are limited to certain groups of patients selected in accordance with the special features of semi-inpatient establishments and in the interest of achieving the best possible results. Persons are selected who, though able to work, are in such a state of health that it is advisable for them to undergo a preventive course so as to ward off any further deterioration of their condition or the threat of other diseases. Cures in an overnight sanatorium are prescribed for prolonged convalescent cures after recovery from a serious illness. Patients are taken to these sanatoria every day at the end of their shift. They not only receive all kinds of medical treatment including massage and electrophysical therapy, but also enjoy cultural activities provided there, and spend their off-time at leisure. Special diets are served if necessary.

A policlinic (outpatient clinic) is defined as a medical institution giving treatment as well as practicing preventive medicine, employing at least three doctors and one dentist. The tasks of a factory policlinic are:

a. The practice of preventive medicine for the protection of the workers in the factory.

b. Participation in running and supervising the labor safety program.

c. First-aid in cases of sickness and accidents.

d. Treatment of outpatients, guaranteeing the patient's free choice of the doctor.

e. Certifying sick people as incapacitated for work after medical examination.

f. Registration and analysis of the increase and decrease of sickness and accidents.

After the founding of the German Democratic Republic, the Law on Labor Protection was passed and put into effect on May 11, 1950. This law embodies a wider application of the previously mentioned order, thus providing the basis for our labor legislation.

The factory health services are particularly concerned with putting into practice what was laid down in the "Decree on the Protection of Workers of October 25th, 1951."

The "Decree on the Further Improvement of the Working and Living Conditions of the Workers and the Rights of the Trade Unions" issued by the Council of Ministers of the German Democratic Republic on December 10, 1953, lays down the principal stipulations on labor safety programs, on the employment of women, youth and other groups, and on continuous medical observation of workers engaged in occupations dangerous to health.

The Decree of July 8, 1954, provides for further promotion of this work on the basis of the experience gained hitherto, and on the introduction of what is called "dispensary care," a method happily uniting preventive medicine and medical treatment in the factory health service. I shall return to this subject later.

The following survey shows the extent of factory health service in the German Democratic Republic.

	1948	1955	1958
Policlinics (Outpatient clinics)	162	291	391
Health centers	119	300	350
Rural health centers	2	298	351
Factory polyclinics	24	78	84
Factory health centers	—	180	190
Factory first-aid departments	1,482	6,881	7,000
District nursing departments	1,500	4,031	4,309
Sick-beds per 1,000 of the population	9.0	11.4	11.8
Sick-beds, total	173,000	203,000	203,269
Places in nurseries	368	50,800	65,883

Primary attention is devoted to the following tasks:

1. The first task of the factory health service is the practice of preventive medicine.

2. Doctors have to study existing working conditions carefully with the aim of combining preventive medicine, medical treatment and medical care for workers on jobs dangerous health.

3. The dispensary method must be introduced at all factory polyclinics, as only this method guarantees the unity of medical treatment and preventive medicine.

Dispensary Care

"Dispensare" is derived from Latin and means to distribute. In France during the Middle Ages, a "dispensaire" was the poor man's chemist's shop. England adopted the same expression, but extended this institution by also granting medical advice.

As early as 1580, Renaudot, a friend of Henry IV and Richelieu, established a dispensary of this type in France. The name reappeared in the Soviet Union, this time denoting a far more comprehensive institution. Medical treatment free of charge for all citizens is considered an obligation of society towards man; it is a transitionary stage in the development of the doctor's part in medicine, from a passive to an active role, which consists in the registration of all persons whose health is endangered by the same causes, or who are suffering from the same disease, and to "distribute" medical aid. The doctor thus no longer waits in his surgery for the patients to come to him; he goes out to look for them instead, attempting the earliest possible detection of any source leading to the illness in question, or detecting the disease itself, possibly in its initial stage. This medical method provides a possibility of uniting preventive medicine and medical treatment.

Dispensary care dates back to a well-known German tradition in medical science. On November 15, 1899, a polyclinic for consumptive diseases was opened at the Berlin University, followed by similar institutions in Greifswald, Halle, Bonn, Marburg, Kiel and Breslau, all university towns. These polyclinics for consumptive diseases were foremost in medical examination care, also showing the first traces of preventive medical care, as they not only aimed at early diagnosis and providing medical knowledge among TB patients, but exerted influence on them in questions of everyday life, distributing pamphlets and teaching students and doctors. Thus, these polyclinics for consumptive diseases became important instruments in the campaign to combat tuberculosis. In 1893, Schlossmann opened the first health center for children in Dresden. Kantorowicz started to look actively for patients with defective teeth, providing treatment at the same time. Special mention should also be made of the well organized campaign against cancer carried through in Hamburg, and the medical attention given to those suffering from diabetes and pernicious anemia at the Greifswald institutes, and the good treatment provided to hypertonics in Rostock and for congenital heart defects in Halle. Taking into consideration the experience gained in Germany and abroad, we consider the general introduction of the dispensary method a necessity for the future of our public health services.

Today, treatment of chronic diseases with slowly developing initial stages is steadily coming to the fore; these are best influenced in their early stages.

Special attention must be paid to the premorbid condition of patients. The transition from health to disease is a continuous process, but despite the difficulties arising from this fact, it is essential to attempt a general character description of the premorbid stages of each type of disease. It is important to make available facts on symptoms which will enable medicine to detect, for instance, the future stomach

ulcer (ulcus ventriculi) patient before he actually is afflicted with this disease.

This task will require years, perhaps decades, of laborious work by doctors in all large factories, health centers and other medical institutions. The causes of disease will not be found in laboratories only; thorough analysis of living and working conditions will be required. The extension of preventive medicine in industry requires that unanimity be reached by scientists on premorbid conditions; this is only to be attained on the basis of regular routine medical examinations. This appears to be possible in the case of stomach disease and arterial hypertension. The effectiveness of this method is based on regarding medical treatment and preventive medicine as different aspects of one whole, and on regarding the organism as a whole also; always taking into account the close relations and interrelations between the organism and its environment. Medical care of the patient, as an outpatient or an inpatient, in health and in sickness, and his environment, all these factors are to be regarded as different aspects of one and the same problem, dealt with at different times, under different circumstances.

We regard it as a fundamental task of the health service to raise the state of health of our population, thus lowering the incidence of disease at the same time.

Dispensary care seems to us to be one way of realizing this objective. In applying this method, the doctor approaches every patient individually, and gets to know his environment and his way of life. The art of applying physiological and clinical data in industry is a most essential part of the factory doctor's work. The fusion of clinic and polyclinic as carried out in our country has proved advantageous for the factory health services.

Dispensary method within the factory health service represents an improvement in medical care for the working people. We intend to consider the rise or fall in sickness as one of the most significant indications of the effectiveness of the dispensary method, which will be applied to certain groups of healthy persons and certain forms of disease.

We intend to apply this method to all persons registered in factory polyclinics, and clinic-polyclinic units.

In the dispensary method the following principles are adhered to:

1. An exact and detailed diagnosis must be made not only of the patient's physical, but also of his psychological condition.

2. Selection of persons suitable for observation in the relevant dispensary groups.

3. Inspection of patient's work place with reference to his psychological and physical state.

4. Helping the patient to settle personal problems.

5. Extensive treatment must be given by a doctor freely chosen by the patient; both doctor and patient receive advice from the dispensary doctor, who may also be the doctor providing the treatment.

6. The dispensary doctor must treat each patient in his group individually.

7. In cooperation with a trade union representative, the dispensary doctor arranges for changes in working conditions indicated by his medical findings in each case.

8. Improvements in working conditions are made for all workers on the basis of the dispensary team's findings.

The significance of this method of approach lies in the following:

1. It leads to a thorough analysis of the causes of accidents and injuries to the workers' health.

2. Detection and registration of a disease at the earliest possible stage guarantee a return to normal health without interfering with the patient's ability to work.

3. Information on public health encourages patients to give their active support to the medical measures taken.

4. Accidents are reduced through an exact analysis of the working place. Results of these analyses are passed on to the workers themselves and this, along with increased activity of those responsible for labor safety precautions, leads in its turn to a reduction in the number of accidents at work.

5. Planned and rational treatment of workers through preventive cures in inpatient and semi-inpatient institutions for the first time insures systematic and efficient use of these facilities.

The change-over to the dispensary method after many decades of experience in medical care for workers marks the true beginning of preventive medicine in this sphere.

The directive issued on August 4, 1956, on the introduction of this method in state and factory health centers is of considerable importance. It provides that diseases of the coronary system and ulcus ventriculi and duodenal ulcer, including postoperative conditions, are to receive priority.

Practice of the dispensary method means regular medical attention and continuous observation of the results obtained, which in turn lead to:

1. The detection of the initial stages of a disease at so early a point that full restoration of the patients' health and ability to work is most probable.

2. Deterioration in cases of disease already present can be avoided.

3. The transition of a disease from the acute to the chronic stage can be prevented.

Doctors should investigate the relation between the first symptoms of the disease and the patients' habits and working conditions and should find ways and means to prevent such diseases through suitable changes in living and working conditions. Thus the dispensary method presents the greatest possibilities of individual preventive treatment. It should be pointed out in this connection that all persons suffering from tuberculosis and cancer are cared for by the dispensary method in our country.

This method permits coordination of treatment and prophylaxis. These are the lines along which we are trying to improve the health services for our working people. In our huge factory polyclinics, employing up to 20 doctors in some cases, it is possible to undertake measures whose scope constantly increases with the extension of our knowledge. A comparatively recent development has been the increased attention focused upon the problem of rehabilitation, by which we mean the reintegration into the working process of persons who have been temporarily incapacitated. The highest possible degree of restoration of the patients' abilities from a physical, mental, social, professional and economic point of view is a precondition for successful rehabilitation.

Insufficient attention to the problem of rehabilitation will inevitably affect the living standard of the entire population. But this is not the sole reason for attributing so much importance to this problem. The individual usually does not consider early invalidity as an ideal state of affairs. The patient becomes dissatisfied and develops a feeling of uselessness. If, on the one hand, it is our task to maintain his ability to work by prolonging a valuable life, we have the duty, on the other hand, to help those suffering from ill health to rehabilitate themselves. We consider this a primary task.

We attach great importance to the provision within the factory of lighter work for partially incapacitated persons. The following points should be considered in this connection.

1. Persons only temporarily incapacitated could possibly remain at their usual jobs, if the demands were reduced (working hours, kind of work, etc.).

2. Providing lighter work where advisable helps to reduce incapacity to work and early invalidity.

3. Providing partially incapacitated persons with lighter work helps them to maintain their will to work, as they are given a chance to regain their former efficiency without undue strain.

4. The great number of relapses due to inability to cope with the demands of work can be avoided; relapses lead to a feeling of inferiority and a deterioration in working morale.

5. Exclusion from the working process, in certain cases, not only is unnecessary but even harmful. A rise in accidents, for instance, occurs during the first period of work after an interval.

Factory welfare work for those partially incapacitated is based on the assumption that a person's efficiency is to a large extent dependent on his attitude to work. The incapacitated person expects to receive adequate attention at his working place. The work expected of him must be of a kind which takes his fluctuating condition into account. We are therefore gradually going over to the employment of psychologists in all big factories.

The dispensary method and rehabilitation work are connected to the extent that dispensary method is also applied in rehabilitation work.

On June 16, 1958, the Working Group of Social Hygienists in the German Democratic Republic held an International Conference on Rehabilitation, Dispensary Care and Premorbid Conditions. There took place valuable exchanges of international experiences which will help to promote this work for the benefit of all peoples throughout the world.

I wanted to show you the high standard of the factory health services in the German Democratic Republic, and especially the good work being done in health protection for the working people. Women's rest rooms, overnight sanatoria, children's nurseries, all these have become everyday features in our socialist industry. Generous financial support, which has increased year by year, is given by our government to promote the extension of these facilities. Scientists strive to create exact scientific data as a basis for the continuation of this work.

Women can send their children to nurseries during working hours. Overnight sanatoria have been opened for our workers, providing not only medical care, but also recreational facilities at the end of their working day. Thousands of places in convalescent homes, spas and sanatoria are today available for the working people in the German Democratic Republic. The social insurance system is run by the working people themselves. Employers and employees each contribute half of the insurance fee. In return, the worker and the members of his family are entitled to full insurance services; all medicine, services in kind, spas or convalescent homes are open to all in need, free of charge.

Science Miniature

Thick Head

CAREY P. McCORD, M.D.

In surgery a broken leg is a broken leg. There is little variation in site, type, severity and complications. It is otherwise in occupational disease work. Every year some 200 diseases appear never previously described. One such item of newness is presented by Goethe, Rinck and Gudmundsson (*Arch. Gewerbepathol. Gewerbehyg.* 17:57, 1959) "Sickness in German Deep Sea Fishermen with Reference to Dentition."

When the German fishing fleets go out for their catches in ocean waters they are attended by hospital ships, floating industrial medical departments. One malady encountered is known to the sailors as "thick head." In this state, when severe, the sailors suffer from intense headaches, vomiting, muscular weakness and pains in the large joints. Patients present facial edema which gives rise to the name of the disease and the urine is grass green in color.

It is understandable that at sea the chief article of meat diet is fish from their own catches. A delicacy in this fish diet is the fish livers and in particular tunny (a type of tuna fish) livers. It is believed that the affection mentioned represents a state of hypervitaminosis from an excess of vitamins A and D. Apart from the green urine this entity has been described under various circumstances unrelated to occupation.

Opportunity exists to debate that this constitutes an occupational disease. Being on the affirmative side it is argued for sailors at sea, that food as furnished is part of the compensation. Ordinarily there is little choice of food. The sailor eats what is put before him. If this be granted, then this form of hypervitaminosis becomes an occupational disease for the German lobscouser.

Letters

To The Editor:

About that "Incident in Chicago," in your July issue, and the group photograph of the AAIP&S organization meeting at Detroit in 1916, some of us "oldsters" can tell you how the fleet-footed physician who appears at both ends of the group found it possible to do so. That picture was made with one of those old cameras that moved through a wide arc. Ty Cobb, of Detroit baseball fame, was the first to appear twice in the same picture. All he had to do was to stand in position such as at the left, and then when the slowly moving scanning camera moved on he ran around the photographer and the camera and took a position at the opposite end before the camera's lens reached that end. After he did it, and at about the time of the making of the AAIP&S picture, the stunt became quite a fad. That was how it was done in that picture. But there is still the mystery of who he was that did it! —A. CUMMULUS, M.D. (Retired)

Abstracts

Development Of a New Fibrinolytic Enzyme and Its Use in Surgical Lesions

J. F. CONNELL, JR. and L. M. ROUSSELT. *Surgery* 47:709 (May) 1960 [St. Louis].

Elase, a new bovine blood fibrinolytic derivative, is specific for fibrin substrates and thus rapidly dissolves fibrinous materials found in serum, clotted blood, and collections of purulent exudate. One of the earliest effects noted was the rapid removal of pus and the subsequent decrease in organism flora. Resistant bacterial strains have not grown out in this study. Elase is compatible with a number of antibiotics and desoxyribonuclease.

Elase in an ointment base was useful on surface ulcers, superficial second degree burns, abscess cavities, wound infections, and sinus tracts. —W. A. WICHOWSKI, M.D.

The Diagnosis of Thyroid Cancer with Radioactive Phosphorus

N. B. ACKERMAN, D. B. SHAHON, and J. F. MARVIN. *Surgery* 47:615 (April) 1960 [St. Louis].

The incidence of thyroid cancer in nontoxic goiter varies but is significant enough to view these goiters clinically with suspicion. In solitary nodular nontoxic goiters the incidence is even greater. Pertinent points in the history of the goiter and in the physical examination such as sudden appearance of the nodule, progressive increase in size, relative fixation, irregular shape, and hardness of nodule may increase the suspicion of cancer, but these are not entirely reliable signs and may be associated with benign lesions. The symptoms of hoarseness, dysphagia, and stridor are significant but occur late in the disease. The radioactive iodine uptake test has been of some value in the diag-

nosis of thyroid cancer since most of the cancers occur in "cold" nodules, that is, nodules with decreased uptake. However colloid cysts and necrotic and nonfunctioning adenomas are also "cold" nodules. Also accuracy of I-131 uptake in glands with small nodules is decreased. Thus a test with more accuracy than the I-131 uptake would be of value.

It is known that radioactive phosphorus (P-32) uptake and metabolism are increased in neoplastic tissue. This increased uptake forms the basis of clinically useful tests in diagnosing cancers of various organs of the body. In studies on excised thyroid tissue, the thyroid/serum ratios of P-32 content were over twice as high in cancerous tissue than in normal and nonmalignant thyroid tissue. In the present study with a small group of patients, results of the thyroid P-32 uptake test have proved promising.

—W. A. WICHOWSKI, M.D.

Books

Communicable and Infectious Diseases

Franklin H. Top. Fourth edition. $20. Pp. 812, with illustrations, some in color. C. V. Mosby Co., St. Louis, 1960.

Industrial medicine is preventive medicine. Communicable and infectious diseases are preventive medicine. Thus a kinship is established and acknowledged. Much of the day by day work of the industrial physician relates to the infectious diseases and notably the diseases of the respiratory tract. On a numerical basis such diseases make up the outstanding nonoccupational unit of the industrial physician's work. This present book in its fourth edition, superb in character, meets all of the needs of the industrial physician. It is complete in its coverage from prevention to therapy. For years to come it is prospective that this book, in its present and future editions, will be regarded as standard.

International Directory of Institutions Engaged in Study, Research and Other Activities in the Field of Occupational Safety and Health, Volumes I and II

Loose-leaf $10. per volume. International Labour Office, Geneva, 1958.

The title of this two volume series in itself well discloses the contents. These two large volumes describe in varying degrees of detail the facilities of occupational health agencies throughout the world. For the majority of industrial physicians these books will provoke no interest. For a few serving in companies or agencies of international import, these books will become invaluable. From them it is possible to determine the facilities, including names and addresses of personnel, in Cairo, Egypt; Helsinki, Finland; Tucson, Arizona, or any other city or any other country wherein occupational health facilities exist. The amount of work and money involved in their compilation must have been stupendous. But their usefulness does not extend to the average industrial physician.

Air Sampling Instruments for Evaluation of Atmospheric Contaminants

Committee on Air Sampling Instruments, American Conference of Governmental Industrial Hygienists. $7.50. Pp. approximately 400, with illustrations. American Conference of Governmental Industrial Hygienists, Cincinnati, 1960.

This loose-leaf, paper bound manual is a revision of Section I of the eight sections of the *Encyclopedia of Instrumentation for Industrial Hygiene* published in 1956 by the University of Michigan Institute of Industrial Health. Some 60 descriptions of new equipment have been added, and latest information on over 40 instruments previously described was obtained from manufacturers and suppliers.

Among the newer instruments is a variety of grab sample devices for quick determination of many gases and vapors. Automatic recording instruments for minute quantities of gases and aerosols have been recent developments. Contributions by operating industrial hygiene units include a device for direct electrostatic precipitation of particulate matter onto electron microscope screens, thus obviating any additional processing prior to examination of the sample.

The original articles in the Encyclopedia have been re-edited and much new material added. The format of the Encyclopedia is retained and the many illustrations are well reproduced in the photolithoprint process. The instruments are organized into nine general classifications following the first section on technical papers. This grouping assists in locating instruments for a given purpose and in making comparisons where several units may be applicable.

As may be expected, some of the most recently developed instruments, of which the NSL portable recording emission spectrograph for beryllium determination and the Mini-Adak automatic recording spectrophotometric analyzer serve as examples, have not been included. However, it is planned to revise this manual every two years.

—WARREN A. COOK

INDUSTRIAL MEDICINE AND SURGERY

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VOLUME XXIX

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The Pathology of Inactivity

Old medical errors never die. One of the hoary errors is that hard labor is conducive to heart disease. The truth is that the religious monk sitting out his endless meditations runs four times the risk of heart attacks or sudden death from heart diseases as compared with the toiling farm laborer. That and much more is written by Dr. J. N. Morris of London in the *A.M.A. Archives of Internal Medicine* (104:903, December, 1959) under the title "Occupation and Coronary Heart Diseases." That author mentions possibly as a better title "Occupational Hazards of Sedentary and Light Work." Under any title, and he refers to the language borrowed as the caption for this editorial, his report is based on a study of coronary heart diseases among London busmen serving on double-decked vehicles. Promptly he found that the "sudden death" rate from heart disease was more than three times greater for bus drivers engaged in a sedentary occupation than for bus conductors obliged to run up and down the stairs of these two level vehicles. For comparison purposes other trades and occupations were investigated as to acute heart affairs. In substance the over-all conclusion was that the greater the physical activity, the lower the heart disease rate and conversely the greater the physical inactivity in the plying of trades and professions, the higher the rate of cardiac affections. Many isolated statements by the author are impressive:

"The drivers (bus drivers) have more coronary heart disease as a whole throughout the 35 to 64 age group but the main occupational difference is in the most malignant form of the disease among the younger men."

"Similar observations were made in government service. Men in three sedentary jobs, office clerks, minor officials, and telephone (switchboard) operators, each had far more rapidly fatal cardiac infarction under 50 years of age than the physically active postmen."

"Generally, light workers were found to have higher coronary death rates than physically active workers and active workers higher than heavy workers."

"A national necropsy survey carried out in Great Britain during the period 1954-56 showed that coronary heart disease was commonest in light workers throughout the 45 to 70 age group. This seemed to be true of fatal coronary heart disease itself. More interesting, among 3,800 deaths from some other cause than coronary heart disease, e.g., accidents or cancer, ischemic fibrosis of the myocardium as a finding at postmortem was commonest in light workers."

"Hypertension without evident primary cause is particularly common in light workers."

"Hypertensive light workers seem particularly liable to coronary heart disease and again particularly at 45 to 59 years of age, judging from the postmortem findings in the necropsy survey."

"Coronary heart disease may be in some measure a deficiency disease. Just as we are accustomed to think of the physiology of exercise, we should be thinking too about the pathology of inactivity of disuse."

The handwriting on the electrocardiogram or the autopsy protocol or the statistician's compilation is unequivocal and reads: to conserve the cardiovascular system, subject it to physical effort, year in and year out. The corollary equally is clear, inactivity and sedentariness favor the appearance of cardiac disease.

The Epileptic Veteran and Employment

The Veterans Administration's brochure 22-6, 1960, is entitled, "Occupations of Epileptic Veterans of World War II and Korean Conflict." This represents no search for occupations suitable for employment for the epileptic but instead consists of brief case presentations of hundreds of veteran epileptics at work. There appear to be few occupational limitations for successful employment of the epileptic. In this series the range is from "sausage maker" to "architect" — both successful.

The most appealing portion of this brochure's content is concerned with the social plight of the epileptic, be he veteran or otherwise. Some related extracts make this situation clear:

"Estimates of the number of persons in the United States who suffer from convulsive seizures range from 800,000 to 1,500,000. The incidence of epileptic seizures is as great as for active tuberculosis or diabetes, and four times more than poliomyelitis. Epilepsy attacks a cross section of the population, occurring in both sexes, in all geographical areas, all races, all economic groups, and at all intellectual levels."

"Half of all persons with grand mal epilepsy are able to remain seizure-free on proper anticonvulsant medication. In another 30%, seizures can be controlled almost completely, and there is no reason why such persons cannot hold jobs and perform them well if the employer is fully aware of the nature and frequency of their seizures after medicine and other treatment have reduced them to a minimum."

"Even though seizures can be controlled, even though the epileptic may not have had a seizure for months on end, even though he may be a qualified worker, he frequently is denied an opportunity in his search for employment. Many of his problems are caused not by his disability, but by a disability of society, a reluctance to accept man for his true worth in spite of his handicap."

"More than most others who are handicapped, the epileptic suffers from rejection by his community, discrimination in employment, and legal barriers. Sometimes he meets these severe pressures by reactions that color his whole personality. With patience and acceptance, many can be helped to make a satisfactory adjustment to the job."

"Further, the assumption that persons subject to sudden loss of consciousness experience more accidents than persons who never lose consciousness is not supported by studies which have been made. Investigation by the U. S. Department of Labor compared the work performance of epileptics with the performance of matched nonepileptic workers. There was no significant difference between the two groups."

"The degree of success achieved by VA rehabilitation personnel in vocational rehabilitation and placement of epileptic veterans probably is lower than that for any other major disability group. Other rehabilitation and employment placement agencies report similar experience. Most of the difficulty is due to the complexities involved, social rejection, restrictive legislation, misconceptions, and anxieties which have persisted and have caused rejection by industry."

Not all such veterans are willing to work or willing to undergo rehabilitation in prospect of employment. This is not their story. This brochure is the success story of hundreds of veteran epileptics who successfully have gone about employment in scores and scores of trades and professions.

Sorry!

On page 338 of the July, 1960, issue of *Industrial Medicine and Surgery*, Springfield College was inadvertently moved to Springfield, Illinois. It remains, of course, in Springfield, Massachusetts.

Dramamine®

brand of dimenhydrinate

...the classic drug for vertigo caused by labyrinthine disturbance.

Each scored, yellow tablet contains 50 mg. of dimenhydrinate, U.S.P.

Average dose: 1 or 2 tablets 3 or 4 times daily.

Dramamine is available in 4 dosage forms: Tablets, Liquid, Supposicones® and Ampuls.

also available for vertigo with anxiety and depression

Dramamine-*D*®

dimenhydrinate with *d*-amphetamine sulfate

controls symptoms . . . improves mood

Average dose: 1 tablet 2 or 3 times daily.

RESEARCH IN THE SERVICE OF MEDICINE **SEARLE**

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"Even though seizures can be controlled, even though the epileptic may not have had a seizure for months on end, even though he may be a qualified worker, he frequently is denied an opportunity in his search for employment. Many of his problems are caused not by his disability, but by a disability of society, a reluctance to accept man for his true worth in spite of his handicap."

"More than most others who are handicapped, the epileptic suffers from rejection by his community, discrimination in employment, and legal barriers. Sometimes he meets these severe pressures by reactions that color his whole personality. With patience and acceptance, many can be helped to make a satisfactory adjustment to the job."

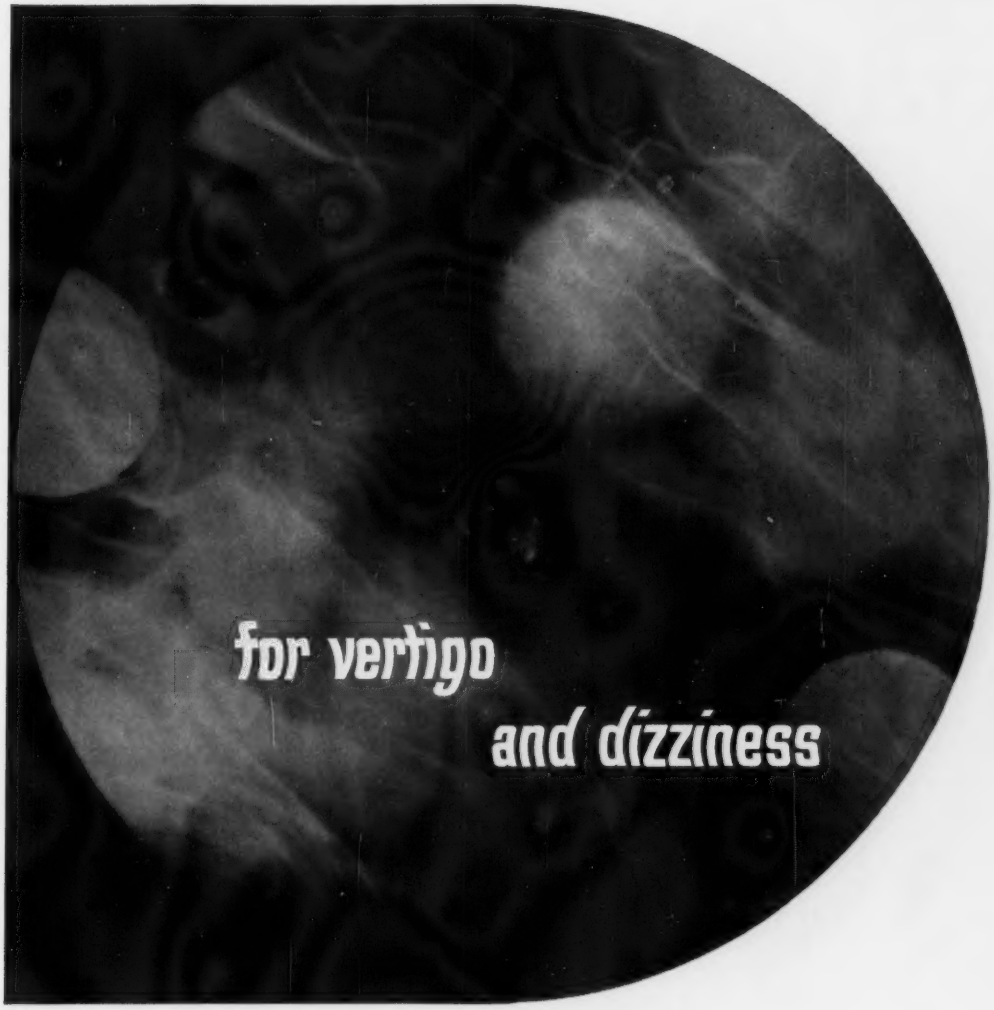
"Further, the assumption that persons subject to sudden loss of consciousness experience more accidents than persons who never lose consciousness is not supported by studies which have been made. Investigation by the U. S. Department of Labor compared the work performance of epileptics with the performance of matched nonepileptic workers. There was no significant difference between the two groups."

"The degree of success achieved by VA rehabilitation personnel in vocational rehabilitation and placement of epileptic veterans probably is lower than that for any other major disability group. Other rehabilitation and employment placement agencies report similar experience. Most of the difficulty is due to the complexities involved, social rejection, restrictive legislation, misconceptions, and anxieties which have persisted and have caused rejection by industry."

Not all such veterans are willing to work or willing to undergo rehabilitation in prospect of employment. This is not their story. This brochure is the success story of hundreds of veteran epileptics who successfully have gone about employment in scores and scores of trades and professions.

Sorry!

On page 338 of the July, 1960, issue of *Industrial Medicine and Surgery*, Springfield College was inadvertently moved to Springfield, Illinois. It remains, of course, in Springfield, Massachusetts.



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COMMENT AND OPINION

Threescore, Nine and 0.7

Average length of life of the American people reached a new high of 69.7 years in 1959, it is reported by statisticians of the Metropolitan Life Insurance Company.

The previous high — 69.6 years — was registered in 1954 and also in 1956. In 1958 it was 69.5 years.

The favorable longevity reflects the marked rise in living standards and the extraordinary advances in medical science and public health administration, the statisticians point out. Not many generations ago the infectious diseases took a heavy toll of life year after year, and often flared to epidemic proportions. The death toll was particularly heavy among young children. For example, in 1850 about one fourth of the newborn died before reaching the fifth birthday. By 1901, not until age 25 were the number of newborn reduced by one quarter. For the babies born in 1930, the corresponding age is 49, and for those born in 1959 it is expected to be 63 years.

The age to which half the newborn survive also has increased substantially. Around 1850 one half of the babies lived to reach age 45. By the turn of the century that point had reached 58 years. For the 1930 crop of babies, one half are expected to reach 67, and under current conditions half of our newborn can expect to live almost 74 years. One quarter of 1959's babies can expect to live 83 years.

"It is doubtful whether the record of gain in life conservation during the past century can ever again be paralleled," the Metropolitan statisticians conclude. "It should be noted that there has been virtually no improvement in longevity since 1954. Some additional gains may be expected from continued declines in the death rates from tuberculosis, pneumonia and other infectious diseases; the toll from accidents may also be reduced. However, the greatest margin for improvement lies in the development of new weapons for postponing and treating the degenerative conditions, which now predominate at the middle and older ages."

Safe Railing

Canadian National Railways has reduced injuries on the job in its Atlantic region by more than 50% since 1954.

Behind this safety record is a program which includes instruction in accident prevention, using films, live demonstrations, pamphlets and posters.

"Our methods have been very successful," Vice-President D. V. Gonder said, "but the hard core of remaining accidents takes persistence and inventiveness to eliminate. Sadly, the many accidents that don't happen breed the kind of indifference that engenders a new crop of them.

In the last 10 years, injuries suffered by CNR Atlantic employees on the job cost the railroad nearly $4 million in compensation payments. Last year CNR paid $460,000 in such benefits.

Though there were fewer accidents, expenses have been rising steadily due to higher benefits and increased hospitalization and medical costs.

"Add the hidden costs, at the usual six-to-one-ratio," said Gonder, "and the real expense of personal injuries is very large."

—From *The Financial Post*, Toronto, Canada, July 2, 1960.

Well-Done, Please

A Chicago dermatologist has concluded that many people work hard to convert "a peaches-and-cream complexion" into "the sun-battered skin of a desert rat." In the June issue of *GP* magazine, Dr. William Becker, Jr., adds that plain vanishing cream, containing 10% para-aminobenzoic acid, "affords 30 times more protection" than many commercial products.

Few people are aware that after a single, moderately-severe sunburn the blood vessels are abnormal for four to 15 months. Although overexposure ages the skin and can cause cancer, sunlight does have beneficial effects. For example, it produces vitamin

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Medical Director: M.D., Univ of Wisc; 6 yrs, med dir & consultant, lge, nationally known co; also, clinical instructor, Indus Med & Lecturer, Occupl hlth, univ med schl; seeks Med Dir, lge institution, MW,NE, or East.

Medical Director: MPH; 10 yrs exper, indus med field; exceptionally qual'd, indus hygiene; prefers New England, Calif or foreign; French & Spanish; middle 40's; immediately available.

Medical Director: 2 yrs, Indus Phys, leading co; 4 yrs, Director, State hlth dept; indus hygiene; since 1955 Director, Med Dept & Safety; wishes to make best use of his high interest and superior background, Indus Med; Cert'd Occupational Med; trng isotopes & radiological defense; late 30's.

Medical Director: 4 yrs, medical ofc, USAC; past ten yrs, Asst Med Dir, very lge co—good position but offers no advancmt; seeks Med dirshp, lge eastern corporation; middle 40's; Diplomate, P.M.

Internist: MPH, Columbia; 2½ yrs, Clinical Hlth Ofc, U.S. overseas mission; 2 yrs, city hlth phys; seeks med dirshp or assoc med dirshp w/clinical duties in Int Med in a comprehensive prepaid med care program—prefer labor med; seeks East; late 30's.

Staff Physician: Two years, Director, Blood & Plasma cntr; three and one-half yrs, private, genl pract; 3 yrs, Med Ofc, USAF; seeks Indus Med in SE, SW or Calif.

Staff Physician: Grad, Rush Med; 13 yrs, very successful private genl & surg pract; (AAGP*; sevl yrs, flight surg, USAF; prefs indus med w/regular hours; no locality preference; middle 40's.

Staff Physician: 3 yrs, med staff member, lge SW corp; leav'g because of family illness—seeks Indus post, Calif, SW, or SE company; immediately available.

Staff Physician: 7 yrs, owned & oper'd 50 bd hsp; wishes change in med career; seeks indus post combining med abil w/adm, counseling or clin rsrch; pref SW or MW, but will locate anywhere; Age 35.

Staff Physician: Interested indus post leading to Med Directorship; 10 yrs, private, genl practice includg 7 yrs as med examiner, lge electric mfgr co; capable genl & ortho surg; any locality; early 40's.

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Medical Director: (a) Dipl, Prev. Med; present Med Dir retiring; want one interested career, Occupational Med; post involves coordination of the med prog in plants and offices of various sizes from coast to coast; lge indus co; $15-20,000; Central.

Associate Medical Director: (b) Clinical med as applied to elaborate executive hlth prog; coordinate med programs in plants, coast to coast; req's yng, personable, Bd int; spec inter could be trop med, psy, prev med, med adm; career post; very important lge indus co; $20-25,000; hdqtr ofc, Calif.

Assistant Medical Director: (c) Duties, overall planning, direct'g staff phys & med servs for all regional plants of impor lge co; hdqtrs, westcoast; requires Int Med backgrnd, OM trng & indus exper; about $18,000; Pacific Northwest.

Staff Physician: (d) Lge co; strategic area, Nat'l Defense progm; 1 yr. contract; about $18,000.

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D in the skin and causes an unexplained drop in blood pressure and serum cholesterol. At the same time, it causes the skin to become dry and lose its elasticity. The color darkens and often becomes a yellowish or blotchy brown. Prolonged overexposure causes a condition known as farmer's or sailor's skin.

Historically, a deep tan has always had social significance; Older cultures regarded tanning and weathering of the skin by sunlight as stigmata of the lower classes. The pale translucent complexion was most desired. This identified a personage as above laboring in the fields. The industrial revolution moved the lower classes indoors. Increasing leisure has altered the attitude toward outside activity. Many segments of current American society endow a deep tan, especially out of season, with an aura of virility, leisure, and wealth. The last two decades have seen Americans indulge in historically unique sun worship — ancient peoples offered sacrifices other than themselves.

Benzophenones, chemicals now being added to plastics, paints, varnishes, etc., may someday help prevent sunburns and skin damage. Although experimental work is in progress, no such commercial preparations are available today. The white skin is not physiologically able to tolerate a large amount of strong ultraviolet light. No simple, absolutely foolproof method of preventing sunburn is known.

Farm Hazards

A farmer's barn and silo are a large source of his livelihood, but they may also be sources of serious lung troubles.

Physicians at a recent two-day University of Wisconsin postgraduate course in Effects of Air Pollution on Environment and Health talked about two of farming's occupational hazards — silo filler's disease and farmer's lung. Scientists told of the silo gas that seems to cause one and the molds that may be responsible for the other. Researchers described lung changes that might be due to air pollution and pointed toward agents in the air that might be doing the damage.

Silo gas is poisonous nitrogen dioxide. Dr. Robert H. Burris, University of Wisconsin Biochemistry Chairman, said some plants, like corn, have a great capacity for taking nitrate from the soil. For the last 20 years, increased use of nitrogenous fertilizers has probably meant even more plant nitrate storage. In the silo the forage gives off nitric oxide which combines with oxygen in the air to produce nitrogen dioxide.

Wisconsin researchers measured production of nitric oxide in a normal silo,

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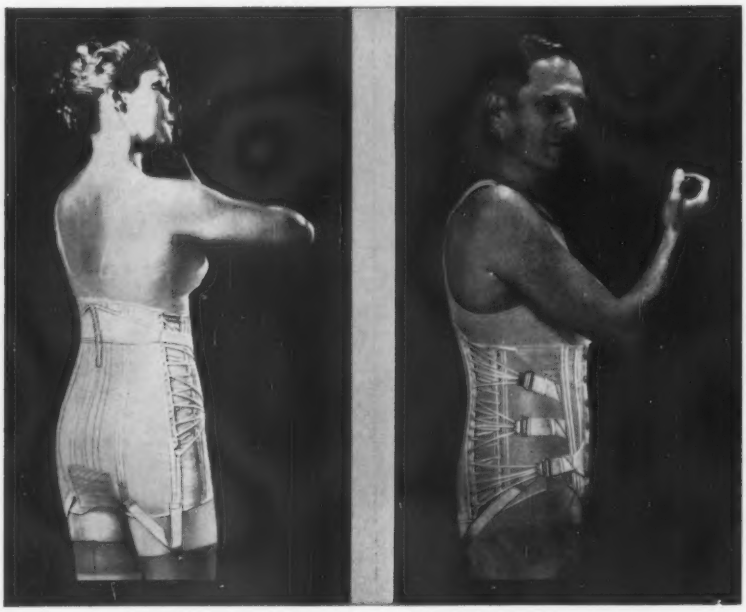

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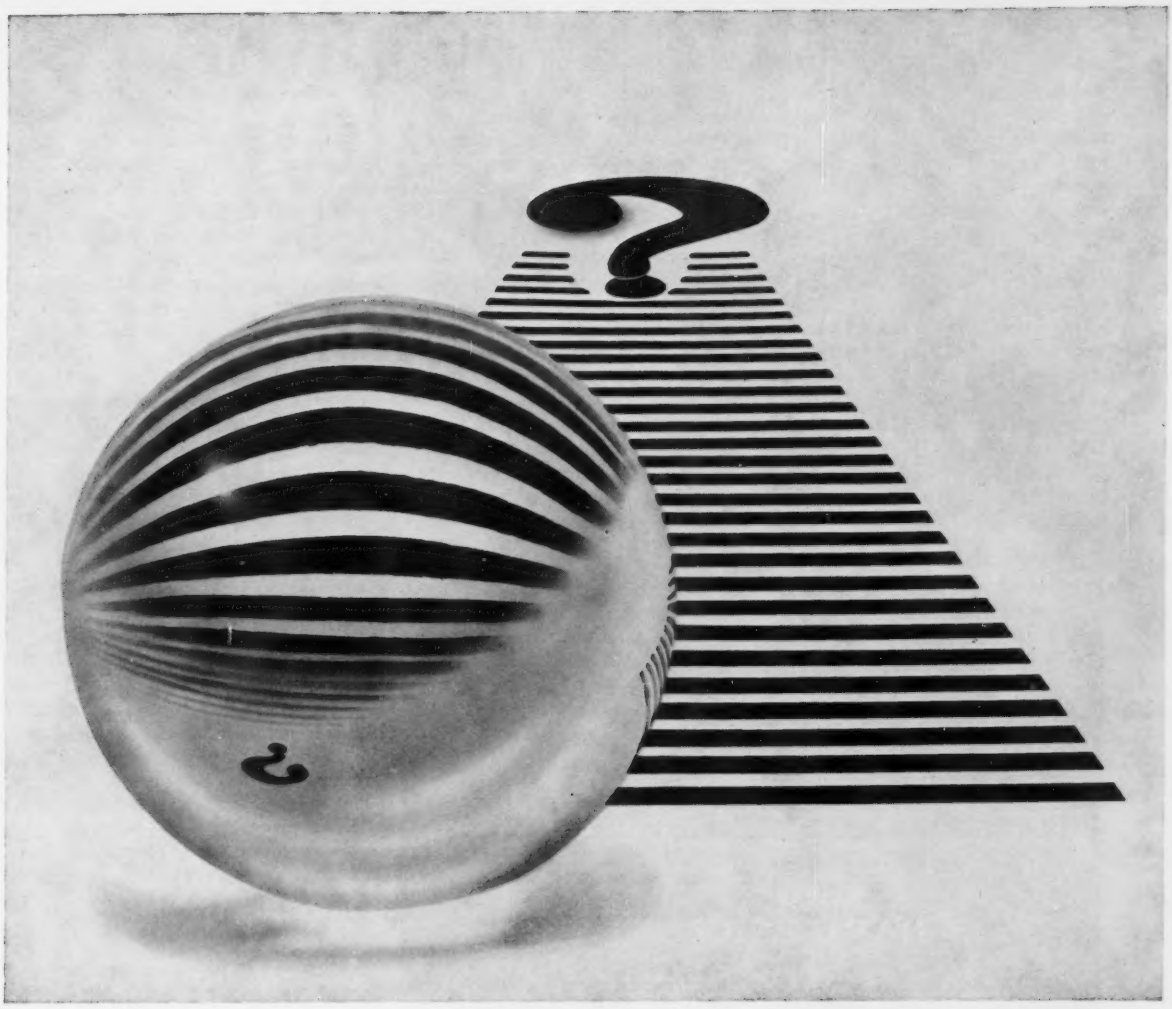

what lurks beyond the broad spectrum?

Broad spectrum antibiotics provide the best means of combating pathogenic organisms which range all the way from large protozoa through gram-negative and gram-positive bacteria to certain viruses at the far end of the spectrum.

But beyond the spectrum lurk pathogenic fungi. It is increasingly apparent that fungal superinfections may occur during or after a course of broad spectrum antibiotics.[1,2] Long term debilitating diseases, diabetes, pregnancy, corticosteroid therapy, high or prolonged antibiotic dosage, and other causes may predispose to fungal superinfections.[1,3,4]

Mysteclin-V controls infection and prevents superinfection. It makes a telling assault on bacterial infections and, in addition, prevents monilial overgrowth.[2,5-8] Mysteclin-V is a combination of tetracycline phosphate complex for reliable control of most infections encountered in daily practice, and Mycostatin, the safe antifungal antibiotic. When you prescribe Mysteclin-V, you provide "broad spectrum therapy" plus extra protection that extends beyond the spectrum of ordinary antibiotics.

In pediatrics: Mysteclin-F for Aqueous Drops and Mysteclin-F for Syrup are phosphate-potentiated tetracycline combined with the new antifungal antibiotic, Fungizone (amphotericin B). They provide good-tasting, fruit-flavored aqueous liquids for your pediatric patients.

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References: 1. Dowling, H. F.: Postgrad. Med. *23*:594 (June) 1958. 2. Gimble, A. I.; Shea, J. G., and Katz, S.: Antibiotics Annual 1955-1956 New York, Medical Encyclopedia Inc., 1956, p. 676. 3. Long, P. H., in Kneeland, Y., Jr., and Wortis, S. B.: Bull. New York Acad. Med. *33*:552 (Aug.) 1957. 4. Rein, C. R.; Lewis, L. A., and Dick, L. A.: Antibiotic Med. & Clin. Ther. *4*:771 (Dec.) 1957. 5. Stone, M. L., and Mersheimer, W. L.: Antibiotics Annual 1955-1956, New York, Medical Encyclopedia Inc., 1956, p. 862. 6. Campbell, E. A.; Prigot, A., and Dorsey, G. M.: Antibiotic Med. & Clin. Ther. *4*:817 (Dec.) 1957. 7. Chamberlain, C.; Burros, H. M., and Borromeo, V.: Antibiotic Med. & Clin. Ther. *5*:521 (Aug.) 1958. 8. From, P., and Alli, J. H.: Antibiotic Med. & Clin. Ther. *5*:639 (Nov.) 1958.

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Dr. Burris said. There were 90,000 parts of the gas per million parts air at peak production, which occurred about 24 hours after the silo was filled. Industrial workers in places where nitric oxide and nitrogen dioxide are produced are not allowed to tolerate more than five parts per million. A crop preservative with metabisulphite in it reduces the production of silo gas, Dr. Burris said, but changes the character of the silage as well.

Dr. Leonard M. Schuman, of University of Minnesota's School of Public Health, spoke on silo filler's disease. He said 11 farmer's deaths had been confirmed as due to this serious agricultural occupational hazard. One of the dangers, he said, was that usually the gas is neither seen nor smelled. The disease hits farmers working in and around freshly filled silos.

Patients Dr. Schuman questioned told him of coughing and choking, of feeling very weak, and of having nausea after a few hours of silo work. He said for two or three weeks after that patients told him they felt a little better, but as if they had asthma. After that time the cough got worse and any exertion would cause a gasping for breath. The best protection, he said, would be to stay clear of silos for at least three days after filling.

Farmer's lung is quite a different disease, said Dr. John Rankin, University of Wisconsin Associate Professor of Medicine. He said it was caused by inhaling moldy, organic dusts, and that it was a type of delayed allergy. Moldy hay, fodder, grain, and threshing dust seemed to be causes.

Patients complained of chills and fever, coughing and severe shortness of breath six or eight hours after working around the dust. The disease left farmers with lung abnormalities, particularly a "stiffness" in the lung.

The condition was reversible, Dr. Rankin said, and if patients took precautions against being re-exposed, abnormalities in most cases disappeared within a year. A study of those who did not take precautions — staying clear of dusty areas or wearing respirators — showed the abnormalities stayed with them, and half of those who ignored precautions were severely disabled. A few of the farmers were totally and permanently disabled.

Be Prepared

Stockpiling influenza vaccine for use against future epidemics is possible now, says a University of Michigan virus researcher, because of a composite vaccine which is effective against a wide variety of flu strains.

Fred M. Davenport, M.D., Professor of Epidemiology at the University of Michigan School of Public Health and Director of the Commission on Influenza of the Armed Forces Epidemiological Board, believes the nation should build such stockpiles, although he admits it would entail a "calculated risk." The alternative, he says, is an endless series of crash programs to fight each new form of influenza.

Dr. Davenport presented his views at the International Conference of Asian Influenza held recently at the National Institutes of Health under the auspices of the U. S. Public Health Service.

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1. Gordon, E. E. and Haas, A.: Industrial Medicine & Surgery 28:217, 1959.

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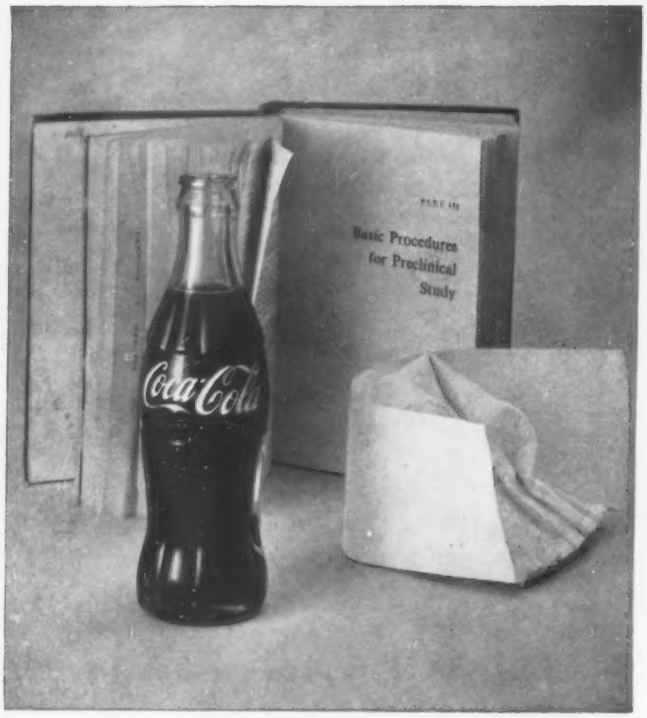

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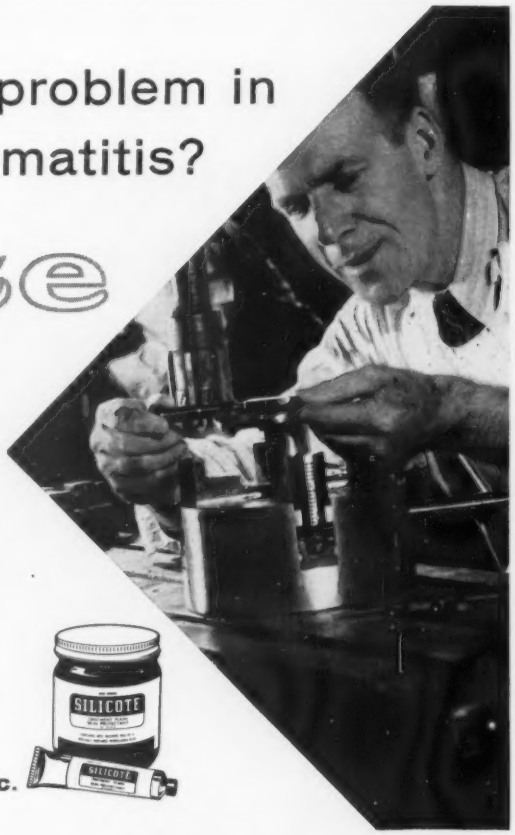

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1. Kelly, J. J., Jr.: Am. J. Med. Sci. *232*:119-128 (Aug.) 1956.

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economical maintenance therapy in atopic dermatoses

Long-term use of topical steroids has real advantages in most eczematous diseases; but this means daily applications for many weeks and even months after visible signs of the disease have disappeared.[1] The 0.25% hydrocortisone topicals afford therapeutic effectiveness at a fraction of the cost.[2]

CORT-DOME®
(pH 4.6)
0.25% micronized hydrocortisone alcohol in the exclusive ACID MANTLE® vehicle.

NEO-CORT-DOME™
(pH 4.6)
0.25% micronized hydrocortisone alcohol plus 5.0 mg./Gm. of neomycin sulfate in the exclusive ACID MANTLE vehicle.

CARBO-CORT™
(pH 4.6)
0.25% micronized hydrocortisone alcohol plus 3.0% liquor carbonis detergens in the exclusive ACID MANTLE vehicle.

CORT-QUIN™
(pH 4.5)
0.25% micronized hydrocortisone alcohol plus 1.0% diiodohydroxyquinoline in the exclusive ACID MANTLE vehicle.

COR-TAR-QUIN™
(pH 5.0)
0.25% micronized hydrocortisone alcohol plus 1.0% diiodohydroxyquinoline and 2.0% liquor carbonis detergens in the exclusive ACID MANTLE vehicle.

DOME

1.) Stoughton, R. B.: Report To The Council; Steroid Therapy In Skin Disorders, J.A.M.A. 170:1311-1315 (July 11) 1959. 2.) Goodman, H.: Concentration of Topical Medications Dispersed in Evaporating Vehicles with Particular Reference to Hydrocortisone Alcohol, Clin. Med. 6:781-784 (May) 1959.

The exclusive ACID MANTLE vehicle potentiates the ingredients in DOME preparations . . . restores and maintains the normal protective acidity of the skin...and facilitates healing.

Available as CREMES in 1 oz. tubes, 4 oz. and 1 lb. jars; and as LOTIONS in 4 fl. oz. bottles.

These preparations are also available with higher hydrocortisone concentrations.

World Leader In Dermatologicals
DOME CHEMICALS INC.
New York - Los Angeles

Proven

in over five years of clinical use and
more than 750 published clinical studies

Effective

for relief of anxiety and tension

Outstandingly Safe

- simple dosage schedule produces rapid, reliable tranquilization without unpredictable excitation
- no cumulative effects, thus no need for difficult dosage readjustments
- does not produce ataxia, change in appetite or libido
- does not produce depression, Parkinson-like symptoms, jaundice or agranulocytosis
- does not impair mental efficiency or normal behavior

Miltown®

meprobamate (Wallace)

Usual dosage: One or two 400 mg. tablets t.i.d.
Supplied: 400 mg. scored tablets, 200 mg. sugar-coated tablets; or as MEPROTABS®– 400 mg. *unmarked*, coated tablets.

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